Project Manual
Book 3 of 3

Chapman Career Center
Tech Upgrades
KDE BG No. 23-406

Holmes Campus
2500 Madison Ave. / Covington, KY 41014

For
Covington Independent Public School District
25 E. 7th Street
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PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 ALTERNATES

A. Within the forms of their bid proposals, contractors shall state the total (labor and material) amount, (with markups), to be added to or deducted from the base bid amount for each of the alternates indicated herein or within the Bid Form or Instructions to Bidders, that the Owner may or may not decide to accept.

1.3 UNIT PRICES

A. Within the forms of their bid proposals, contractors shall state the total labor and material unit price (with markups) for each of the unit scope-of-work items that might be added or deducted on a unit-by-unit basis during the construction period of the project, that takes place before final inspection or date of acceptance review. See Bid Form or Instructions to Bidders as relates to these unit cost items.
   1. Indicate all unit costs, including controls, wiring and interlocks, as outlined and referenced within the bid form or Instruction to Bidders.

1.4 GUARANTEE

A. In entering into a contract covering this work, the Contractor accepts the Specifications and Drawings and guarantees that the work will be carried out in accordance with the requirements of the Specifications and Drawings or such authorized modifications as may be made in the Contract Documents. Contractor further guarantees that the workmanship and material will be first class and that only experienced workers, familiar with each particular class of work, will be employed. Contractor further guarantees to replace and make good at his own expense any defects due to faulty workmanship or material which may develop within one (1) year after final payment and acceptance by the Owner, upon receipt of written notification of defect from the Owner.

1.5 QUALITY ASSURANCE

A. Regulations and Standards: All equipment, apparatus, and systems are to be fabricated and installed in complete accordance with fire and insurance rules and regulations, the Life Safety Code, and the latest edition or revision of the following applicable regulations, standards, and codes:
   1. AIA American Institute of Architects
   2. ASME American Society of Mechanical Engineers
   3. ASTM American Society for Testing and Materials
   4. NFPA National Fire Protection Association
   5. NEC National Electric Code
   6. OSHA Occupational Safety and Health Administration
   7. UL Underwriter's Laboratories, Inc.
   8. MCAA Mechanical Contractors Association of America, Inc.
   9. ANSI American National Standard Institute

10. MSSV Manufacturer's Standardization Society of the Valve and Fitting Industry
11. AWWA American Water Works Association
12. AGA American Natural Gas Association
13. PDI Plumbing and Drainage Institute
14. NACE National Association of Corrosion Engineers
15. State and Local Inspection Authorities
16. Division 01 Sections “Regulatory Requirements: and “Reference Standards” of the Project Specifications
17. References on the Drawings or in the Specifications to "code" or "building code" not otherwise identified shall mean the specific codes applicable to this Project location, together with all additions, amendments, changes, and interpretations adopted by code authorities having jurisdiction over this Project.
18. The applicable edition of all codes shall be that adopted at the time of issuance of permits by the authorities having jurisdiction, and shall include all modifications and additions adopted by that jurisdiction.
19. Give all required notices so as to comply with, and meet, all inspections required by Federal, State, and Local authorities.
20. It is not the intent herewith to modify, reduce, or change any rules, standards, regulations, or requirements that are applicable under local, state and federal codes, ordinances, or regulations of the various authorities having jurisdiction. Where the standards differ among the various authorities, the most restrictive shall apply. Where the requirements shown on the Drawings or called for in the Specifications exceed code requirements, these Drawings and Specifications shall take precedence. Where the requirements within the specifications of this division of work and the Drawings conflict with the referenced Divisions, Sections, and other documents, the documents having the most restrictive and the higher cost requirements shall apply.

1.6 JOB CONDITIONS AND COORDINATION

A. Local Conditions
1. Each Trade Contractor is to inform himself of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work to be done.
2. Contractors shall coordinate and review indicated utility data with the local utility companies.

B. Present Job Site Inspection
1. Each contractor shall schedule through the Owner a visit to the present site proposed for the work before presenting a Bid and shall make a careful inspection of the existing conditions.
2. During the site visit, each Trade Contractor is to investigate for any existing conditions and responsibilities which are not clearly defined by the Drawings and Specifications. If any such conditions exist, he/she shall bring them to the attention of the A/E in writing. The A/E will then make the required written clarification. The absence of questions before the opening of bids shall indicate a clear understanding of the scope of work and the Contractor's responsibility.

C. Concrete Housekeeping Pads and Supporting Foundations
1. Unless otherwise specified or noted on the Drawings, the Concrete Contractor is to provide concrete pads and foundations as indicated on the Drawings for all mechanical equipment.

2. Concrete pads as may be indicated are based upon the design and layout-based manufacturer and model of equipment and devices as specified or as scheduled or noted on the Drawings.
3. The individual Trade Contractor furnishing the equipment or devices is to verify and coordinate all concrete pad sizes so as to have same of proper size to serve the equipment or device supplied and verify the position of all anchor bolts.
4. Any additional cost for larger than indicated pad or foundation sizes to fit the approved manufacturer and model of the equipment or devices is to be borne by the Trade Contractor who supplies such equipment or devices.

D. Permits and Fees: This Contractor is to obtain all permits and pay all fees required for the work under Division 22 of the Work.

E. Royalties and Patents
1. The Trade Contractor is to pay all royalties and license fees. He/she shall defend, indemnify, and hold the Owner and A/E harmless from any and all suits, demands or claims for infringement of any patent rights.
2. The review by A/E or Owner of any method of construction, invention, appliance, process, article, device or material of any kind is to be for adequacy of work, and is not to be construed as an approval of the use thereof by the Contractor in violation of any patent or other rights of any third person.

F. Wiring and Conduit Requirements: In general, most wiring and conduit requirements are addressed, either upon the Drawings as a part of a packaged equipment assembly specifications, or within *Divisions 26, 27 and 28* of the Specifications. However, should an equipment component, panel, or system device need additional wiring and conduit so as to be complete, approved and fully operational, the Contractor who supplied the equipment component, panel or system device shall be responsible for the required wiring and conduit as well as circuit disconnect and protection for same when it is not otherwise covered by the Project Drawings and Specifications.

G. Coordination: Coordinate the exact location of this work with the work of other trades prior to fabrication or installation of same. Verify all dimensions and elevations. Provide additional offsets and sections of material as may be required to meet the applicable job condition requirements. Coordinate with and review all related construction Drawings and Shop Drawings of all equipment suppliers prior to start of work.

1.7 SPECIFICATIONS AND DRAWINGS

A. These specifications and Drawings are intended to describe and provide for a complete and finished project. They are intended to be complementary. All items of work called for by either shall be as binding as if called for by both. The work described shall be complete in every detail, notwithstanding the fact that every item necessarily involved is not particularly mentioned or shown.
1. If the Bidder, Supplier or Contractor sees anything to question, it must be brought to the attention of the A/E immediately.

B. Minor Deviations: The Drawings accompanying these Specifications indicate the general design and arrangement of equipment, apparatus, fixtures, accessories and piping necessary to complete the installation of the system. The exact location or arrangement of the apparatus and equipment, unless otherwise dimensioned, is subject to minor changes necessitated by field conditions and shall be required without additional cost to the Owner. Measurements shall be verified through actual observation at the construction site. Each Trade Contractor shall be

responsible for fitting all of his/her work into place in a satisfactory and workmanlike manner, to the approval of the A/E and Owner.

C. Provide all labor and materials necessary for the completion of the work described. Referenced codes and industry standards and methods shall apply when no other specifics are indicated. Bring questions relating to this paragraph to the attention of the A/E for resolution prior to the receipt of Bids.

D. All Work indicated on Drawings, diagrams, or details in part only are to continue throughout unless distinctly marked otherwise. The same applies to other parts of the project where merely a typical reference plan, diagram, or section of the drawing is complete. The balance is intended to be the same as the typical plan, section, or diagram as shown and is to be figured accordingly.

E. The specifications are divided into trades and divisions only for the distinct purpose of facilitating the work. However, the Trade Contractor will become responsible for furnishing all labor and materials necessary to complete the project as contemplated by the Drawings and Specifications. Any item mentioned under any heading of the Specifications must be supplied even though it is not called for again under the heading for the respective work.

F. Should discrepancies occur within the Contract Documents, the more stringent and more costly approach shall apply for bidding purposes. The Contractor is to notify the A/E of discrepancies for clarification. Clarifications issued after the Contract is awarded shall be incorporated by the Contractor at no additional costs and shall be reviewed by the A/E to determine if a reduction in cost is justified.

1.8 TRADE CONTRACTORS, SUBCONTRACTORS AND SUPPLIERS

A. The Trade Contractor is any person or organization who contracts to perform work for the Project. Wherever the word "Contractor" is used on the Drawings or in the Specifications, it shall be construed to mean the Trade Contractor applicable to the Title Division of these specifications.

B. A Sub-Contractor is a person or organization who has a direct contract with a Trade Contractor to perform any of the Work at the site and includes all who furnish material worked to a special design in accordance with the Drawings and Specifications, but excludes suppliers or persons furnishing material not specially designed. Wherever the term "Sub-Contractor" is encountered in the Contract Documents, it shall mean the Sub-Contractor and/or his/her Sub-Sub-Contractors and/or his/her Material Suppliers.

C. A Sub-Sub-Contractor is a person or organization who has a direct or indirect contract with a Sub-Contractor to perform any of the Work at the project site or for the subject project.

D. A Material Supplier is a person or organization who has a direct contract with a Trade Contractor to furnish material not specially designed.

E. It shall be the responsibility of each Trade Contractor to be fully familiar with various local trade jurisdictional requirements and to engage the services of any other Sub-Contractors as may be required within the various trades to complete all of the work as indicated upon the Drawings and within the Specifications under his/her respective division or section. Only Trade Sub-Contractors with established knowledge and skills of their specific trade shall be used, so that all work is performed in a complete, finished, and professional manner.

F. Whenever any provisions of the Specifications conflict with any agreements or regulations in force among members of any Trade Associations, Unions, or Councils which regulate or distinguish what work shall or shall not be included in the work of any particular trade, the Trade Contractor shall make all necessary efforts to reconcile any such conflict without delay, damage or cost to the Owner.

G. If the progress of the work is affected by any undue delay in furnishing or installing any items of material or equipment required under the contract because of a conflict involving any such agreement or regulation, the A/E may require that other material or equipment of equal kind and quality be provided at no additional cost to the Owner.

H. Any Trade Contractor, subcontractor, or material supplier not normally employing union labor shall make all provisions necessary to avoid any resulting disputes with labor unions and shall be responsible for any delays, damages or extra cost caused by employment of such non-union labor, except as otherwise governable by state or federal rules and regulations.

I. Each Trade Contractor shall pay for all applicable Federal, State and local taxes on all materials, labor or services furnished by him, and all taxes arising out of his/her operations under the Contract Documents which may be imposed upon or collectable from the Owner or become a lien against his/her property. Such taxes shall include, but not be limited to, Occupational, Sales, Use, Excise, Social Security and Unemployment Taxes, customs duties, and all income taxes and other taxes now in force or enacted prior to final acceptance of the work. The Trade Contractor shall assume all liability for the payment of and shall pay any unemployment benefits payable under any Federal or State law to individuals employed by him during the progress of the work covered by the Contract.

J. It is the responsibility of each Trade Contractor to coordinate the various related equipment requirements between his subcontractors, suppliers, and other trade contractors, and to also follow the approved manufacturer's installation instructions.

1.9 OPERATIONAL AND MAINTENANCE INSTRUCTIONS

A. All operational and maintenance instructions that are provided to various Owner-selected members of the facility engineering and/or maintenance staff are, at the same time presented, to be fully videotaped by the Contractor so that all such sessions can be later reviewed by the Owner's staff on a retraining basis as needed. All such videotapes are to become the property of the Owner at the end of each applicable training period, with one copy of each also being supplied to the A/E for the A/E project files.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/PRODUCTS/SUBMITTALS

A. Under the Base Bid, no other manufacturers except those indicated on the Drawings or those listed within the Sections of this Division, that are, in turn, able to comply with the contract document requirements and minimum standards of these specifications, will be acceptable. In addition to specific required "Alternates," proposed substitutions that may or may not be acceptable to the Owner may be submitted by the Contractor only at the time of initial base bid submittal.

B. Although design-based models of various manufacturers may be indicated within the various schedules, it is the responsibility of the various equipment manufacturers to verify the model selections so that all items of equipment comply with the minimum standards of performance

that are indicated within the schedules, as well as the requirements within various sections of the specifications under which the equipment is also specified.

C. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittals”.

D. Shop Drawings are to be submitted on each item of specified or scheduled equipment, valves, specialties, insulation, fixtures, drains, controls and related accessories. All control submittals must include a typed sequence of control for each system.

E. Coordination and Fabrication Drawings: Prepare layout drawings of all system assemblies of this Contract including plumbing, heating, sprinkler piping, electrical and technology, mechanical and electrical room layouts with equipment and piping, ductwork installations, and control systems. Include completely dimensioned plans drawn to scale. Show elevations and sections indicating locations of all equipment, piping, ductwork, drains, controls, and other items with reference to columns, walls, slabs, beams, and to components of other systems and work of other trades. Floor plans shall be drawn at not less than 1/4 inch scale with a sign-off block including all disciplines and date. Tracing or reproduction of Construction Documents is not acceptable. Provide a minimum of one reproducible drawing and five prints of each drawing.

2.2 ACCESS DOORS AND PANELS

A. Unless otherwise indicated, each Trade Contractor is to locate and furnish all access doors required for non-accessible surfaces (such as ceilings, walls, chases, and similar locations), so that all valves and similar items are easily accessible for operation, inspection and maintenance. Access doors for ceiling, walls, chases, etc. are to be installed by the General Contractor. The Trade Contractor is to bear the costs of the installation of the access doors.

2.3 SLEEVES

A. Each Contractor is to provide properly sized, secured and firestopped sleeves for all of their piping systems at all penetrations of walls, foundations, partitions, floors and roofs throughout the entire facility.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all materials, labor, equipment, and services necessary for a complete and operable installation as specified and shown on the Drawings. The word "Provide" shall mean "Furnish and install."

B. Provide new material and equipment in strict accordance with these Specifications and the Project Drawings.

C. At all times, take such precautions as are necessary to protect materials from damage. Close all pipe openings to prevent obstructions and contamination.

3.2 CUTTING AND PATCHING IN BUILDINGS

A. Each Contractor is responsible for all costs associated with the necessary cutting and patching as required for the installation of his work, unless otherwise indicated.

B. Patching is to be performed by the trade proper for each material to be patched. Patching shall leave premises and finishes in a complete and neat condition comparable to the original. Painting of patched surfaces to be by the painting sub-contractor of the General Contractor, unless otherwise specifically indicated or the plumbing/fire protection contractor is the prime contractor for the project. Maintain the fire integrity of all walls, floors, ceilings, and partitions.

3.3 PROTECTION

A. Protect equipment and trim against damage and injury due to building materials, acid, tools, equipment and any causes incidental to construction. Cover the finished surface of each piece of equipment with building paper or similar protection. Replace all equipment damaged by any cause and any trim with marred or scratched finish at no cost to the Owner, upon receipt of written notification from the A/E.

B. Where materials to be installed are being stored at or near the project during construction, arrange such materials so as to minimize the possibility of contamination, corrosion and damage. Keep ends of pipe, equipment, and specialties properly closed during construction and installation to avoid the possibility of miscellaneous materials being placed in the openings.

3.4 PAINTING

A. See Division 09 Section “Interior Painting”.

3.5 WORK IN EXISTING BUILDING

A. Where relocation of existing equipment and piping systems is necessary in areas providing uninterruptible services, schedule work for minimal downtime during slack periods.

B. Locate existing piping and make connections required.

C. Do not cut into existing services without first verifying with Owner that service has been correctly identified.

D. Perform work that interrupts any service (this includes cutting into existing lines for new connection) at time (usually night) to cause least interference to normal operation of building.

E. Inform building engineering staff in advance of all shut-offs that will occur and give estimate of duration.

F. Begin work only after engineering staff is fully informed and has agreed to shut-off schedule.

G. Maintain all existing services and equipment unless indicated to be removed.

H. Salvage items in accordance with Division 02 Section Structure Demolition.

3.6 ADJUST AND CLEAN

A. Inspect all equipment and put in satisfactory working order.
   1. Clean all exposed and concealed items.
   2. Clean floor drains, cleanouts, and plumbing fixtures.
   3. Clean specialties such as traps and strainers and all equipment surfaces such as pumps, motors, etc.
   4. Clean all covers.
   5. Clean exposed piping.

6. Adjust pumps, balancing valves, and metering faucets for proper flow rates.
7. Adjust water heaters and thermostatic mixing valves for required temperatures.

END OF SECTION 220501

SECTION 220507 - EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Each Trade Contractor is to provide all excavating, trenching, sheeting, bracing, pumping, and backfilling as required for the installation of his work.

1.3 QUALITY ASSURANCE

A. Testing
1. All testing is to be done by an independent testing laboratory employed by this Contractor and approved by the Owner and A/E.
2. Conduct up to 10 tests per Trade per 40,000 gross square foot of compacted surface serving each Trade's specific area of work to determine the compaction density of backfill.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

C. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

D. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

G. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

H. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

I. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
1. Yellow: Gas, oil, and dangerous materials.
2. Blue: Water systems.
3. Green: Sewer systems.

PART 3 - EXECUTION

3.1 GENERAL PROTECTION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by A/E. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract time may be authorized for rock excavation.
1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.6 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
1. Fill unauthorized excavations under other construction or utility pipe as directed by A/E.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.

2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.

D. Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe.
1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
1. Under steps and ramps, use engineered fill.
2. Under building slabs, use engineered fill.
3. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.14 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace soil material to depth as directed by A/E; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 220507

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

PART 2 - PRODUCTS

2.1 EQUIPMENT MOTORS

A. Motors shall be of sufficient size for the duty to be performed and shall not exceed the motor's full-rated load when the driven equipment is operating at specified capacity under the most severe conditions likely to be encountered. Motors shall be established, U.S.-manufactured industry standard types for the service intended, having normal starting torque and low starting current characteristics, unless other characteristics are specified. When electrically driven equipment is furnished which materially differs from the contemplated design, the Contractor supplying the driving equipment shall pay for and make necessary the adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed. Motors and equipment shall meet NEMA MG1, and State and Local Energy Code minimum COP requirements. Provide suitable overload protection for each motor.

B. Unless otherwise specified or noted on the Drawings, motors shall be suitable for the service intended, shall be of latest industry standards of design for maximum energy efficiency, and shall be continuous-duty-type, as follows:
   1. Motors less than 1/2 HP shall normally be 120-volt, 1-phase, 60-HZ.

C. Coordinate and verify voltage and phase required with Electrical Drawings, as well as equipment scheduled data.

D. It shall be the responsibility of this contractor to coordinate and verify the applicable phase and voltage requirements with the electrical contractor before submittal of Shop Drawings.

2.2 MOTOR CONTROLLERS AND DISCONNECTS

A. Except as otherwise specified in each of the various sections of Division 22, motor controllers and disconnects shall be as specified under Divisions 26, 27 and 28.

B. Verify applicable voltage, phase, and protective device requirements with electrical contractor before manufacture or installation of equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall comply with manufacturer's latest published instructions and all applicable inspection and code authority requirements.

3.2 MOTOR EFFICIENCIES

A. Drip-Proof Motors

3600 RPM		*1800 RPM*	
HP	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**	**HP**	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**
1-1/2	81.0	1	84.0
2	84.0	1-1/2	84.0
3	86.0	2	84.0
5	87.0	3	88.0
7-1/2	87.0	5	88.0
10	88.0	7-1/2	90.0
15	90.0	10	90.0
20	90.0	15	91.0
25	91.0	20	91.0
30	91.0	25	93.0
40	91.0	30	93.0
50	91.0	40	93.0
60	92.0	50	94.0
75	93.0	60	94.0
100	93.0	75	94.0
		100	94.0

B. Totally Enclosed, Fan-Cooled Motors

3600 RPM		*1800 RPM*	
HP	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**	**HP**	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**
1-1/2	81.0	1	81.0
2	84.0	1-1/2	84.0
3	84.0	2	82.0
5	86.0	3	82.0
7-1/2	88.0	5	85.0
10	90.0	7-1/2	87.0
15	91.0	10	89.0
20	91.0	15	91.0
25	91.0	20	92.0
30	92.0	25	92.0
40	92.0	30	93.0
50	93.0	40	93.0
60	93.0	50	94.0
75	94.0	60	94.0
100	94.0	75	94.0
125	95.0	100	95.0
150	95.0	125	95.0
200	95.0	150	95.0
		200	95.0

END OF SECTION 220513

SECTION 220519 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. This Section the includes the following types of meters and gauges:
   1. Temperature gauges and fittings.
   2. Pressure gauges and fittings.

B. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 22 specifications.

1.3 QUALITY ASSURANCE

A. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.

B. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

1.4 SUBMITTALS

A. Shop Drawings: Each equipment and material item specified.

B. Product Data: Product data for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.

C. Samples: Not required for review.

D. Contract Close-Out Information
   1. Maintenance data for each type of meter and gauge in each building for inclusion in Operating and Maintenance Manuals specified in Division 01, and Division 22 Section "Common Work Results for Plumbing".
   2. Portable test plug test kit and portable meter receipts as described in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Thermometers
      a. Marshalltown Instruments, Inc.
      b. Trerice (H.O.) Co.
      c. Weiss Instruments, Inc.
   2. Thermometer Wells: Same as thermometers.

a. Insertion Dial Thermometers.
b. Ashcroft Dresser Industries/Instrument Div.
c. Trerice (H.O.) Co.
d. Weiss Instruments, Inc.

3. Pressure Gauges
   a. Ametek, U.S. Gauge Div.
   b. Ashcroft Dresser Industries/Instrument Div.
   c. Marsh Instrument Co., Unit of General Signal.
   d. Marshalltown Instruments, Inc.
   e. Trerice (H.O.) Co.
   f. Weiss Instruments, Inc.
4. Pressure Gauge Accessories: Same as for pressure gauges.
   a. Water Orifice-Type Measurement System.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett, ITT, Fluid Handling Div.
5. Test Plugs
   a. MG Piping Products Co.
   b. Peterson Equipment Co., Inc.
   c. Sisco, A Spedco, Inc. Co.
   d. Trerice (H.O.) Co.
   e. Watts Regulator Co.
   f. Flow Design, Inc.

2.2 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1% of range span or plus or minus one scale division to maximum of 1.5% of range span.
   1. Scale Range: Temperature ranges for services listed as follows:
   2. Domestic Hot Water: 30 deg to 240 deg with 2 deg scale divisions (0 deg to 115deg C with 1 deg scale divisions).
   3. Domestic Cold Water: 0 deg to 100 deg F with 2 deg scale divisions (minus 18 deg to 38 deg C with 1 deg scale divisions).

2.3 THERMOMETERS

A. Case: Die-cast, aluminum finished in baked epoxy enamel, glass front, spring-secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Red reading, organic liquid-filled magnifying lens.

D. Scale: Satin-faced, non-reflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.4 DIAL-TYPE INSERTION THERMOMETERS

A. Type: Bimetal stainless steel case and stem, 1-inch diameter dial, dust and leakproof, 1/8-inch diameter tapered-end stem with nominal length of 5 inches.

2.5 THERMOMETER WELLS

A. Brass or stainless steel, pressure-rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.6 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube-type, bottom connection.

B. Case: Drawn steel or brass, glass lens, 4-1/2-inch diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1% of range span.

F. Range: Conform to the following:
1. Vacuum: 30 inch Hg to 15 psi
2. All fluids: 2 times operating pressure

2.7 PRESSURE GAUGE ACCESSORIES

A. Siphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.8 TEST PLUGS

A. Test plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and two self-sealing valve-type core inserts suitable for inserting a 1/8 inch O.D. probe assembly from a dial-type thermometer or pressure gauge. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:
1. Air, Water, Oil, and Gas, 20 deg to 200 deg F (minus 7 deg to 93 deg C): Neoprene
2. Air and Water, minus 30 deg to 275 deg F (minus 35 deg to 136 deg C): EPDM

C. Ranges of pressure gauge and thermometers shall be approximately two times systems operating conditions.

PART 3 - EXECUTION

3.1 THERMOMETER INSTALLATION

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.2 INSTALLATION OF PRESSURE GAUGES

A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most legible position.

B. Install pressure gauges at top of hot and cold water risers.

C. Install pressure gauge at incoming water service.

D. Pressure Gauge Needle Valves: Install in piping tee with snubber.

3.3 INSTALLATION OF TEST PLUGS

A. Test Plugs: Install in piping tee where indicated, located on pipe at most legible position. Secure cap.
   1. Install test plugs adjacent to each piping point where a temperature sensing device is required by control specifications.

B. Test Kit: Provide test kit consisting of one pressure gauge, gauge adapter with probe, two bimetal dial thermometers, and carrying case. Turn over to Owner at completion of job and obtain written receipt. Forward copy of receipt to A/E as part of close-out documents.

3.4 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other sections of Division 22. The drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

B. Install meters and gauges piping adjacent to machine to allow servicing and maintaining of machine.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 QUALITY ASSURANCE

A. Valve Bodies, Shells and Seats: Factory-tested.

B. Standard for 125 psi and 150 psi saturated steam rated valve pressure containing parts: ASTM B62.

C. Standard for 200 psi and 300 psi valves with metallic seats: ASTM B61.

D. Iron Body Valves
   1. Pressure-Containing Parts: ASTM A126, Grade B.
   2. Face-to-Face and End-to-End Dimensions: ANSI B16.10.
   3. Design, Workmanship, Materials, Testing: MSS-SP-70, 71.
   4. Use domestically manufactured valves where required by a Buy American Plan.

E. Butterfly Valves
   1. Face-to-Face and End-to-End Dimensions: MSS-SP-67.

F. Valve Stems: ASTM B371, Alloy C69400; ASTM B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.

G. Pressure Castings: Free of impregnating materials.

H. Manufacturer's name or trademark and working pressure stamped or cast into body.

I. 42 USC 300G: The Reduction of Lead in Drinking Water Act.

1.3 SUBMITTALS

A. Shop Drawings: Schedule indicating proposed valve for each application.

B. Product Data
   1. Manufacturer's cut sheets and/or literature.
   2. Performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information

1. Valve chart indicating valve identification number, valve type, service, manufacturer and model number, and location of valve.
2. Operating and maintenance manuals.

1.4 JOB CONDITIONS

A. Coordinate the exact application and location of this work with the work of other trades prior to installation within various piping systems. Verify all positions and elevations. Provide additional offsets and section of piping as required to position valves for equipment clearance and accessibility as well as system and valve operational conditions.

B. Valve manufacturer to verify indicated figure or model numbers so that selection meets required description and conditions specified. Specified data for valve shall take precedence over indicated figure or model number. Provide proper seat and seal material for applicable temperature, pressure and service indicated for each valve application.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Gate, Butterfly, Check & Ball Valves: Stockham, Nibco, Hammond, Crane, Jenkins, Powell, Milwaukee, Homestead, Apollo, Mueller, A. Y. McDonald.

2.2 DOMESTIC WATER VALVES

A. For gauge valves within steel or copper lines of 1/8 inch or 1/4 inch size, threaded or solder, 150 psig steam or 300 psig w.o.g., union bonnet, integral seat, renewable seat and disc, bronze globe valve conforming to MSS-SP-80, ASTM B-62.

B. For service valves within steel piping of 1/4 inch through 2-1/2 inch size; two-piece ball valve with bronze FNPT threaded ends, lever handle, stainless steel ball and stem, Class 150 SWP-600 w.o.g.

C. For service valves within 1/4 inch through 2 inch size copper piping, similar to above except for solder ends.

D. For service valves in copper piping 2-1/2 inch through 4 inch size; 200 psi w.o.g. butterfly valve, wafer body, suitable for dead-end and isolation service.

E. For service valves within steel piping of 3 inch or above; 200 psig w.o.g butterfly valves, installed between standard ANSI Class 125/150 flanges, suitable for dead-end and isolation service without use of downstream flanges. 3 inch through 6 inch size valves to have manual stem position, lock to prevent tampering, notched plate and latching handle while valves of 8 inch size and above shall have manual enclosed weatherproof handwheel actuators with gear box and position indicator window, and all meeting the following criteria.

	Part	**Specifications**
1.	Stem	Stainless Steel, ASTM A-582 Type 410
2.	Collar Bushing	Brass, ASTM B-124
3.	Stem Seal	EPDM

	Part	Specifications
4.	Body Seal	EPDM
5.	Nameplate	Aluminum
6.	Upper Bushing	Copper CDA 122
7.	Liner	EPDM
8.	Disc	Al. Bronze, ASTM B-148 Alloy 954/955
9.	Lower Bushing	Copper CDA 122
10.	Body (Lug)	Ductile iron, ASTM A-536

F. For check valves within horizontal steel or copper lines through 2 inch size, bronze check valve with teflon disc, threaded ends, Class 150 swp-300 w.o.g., as follows:

	Part	Material	Specifications
1.	Body	Bronze	ASTM B62
2.	Cap	Bronze	ASTM B62
3.	Lever	Bronze	Commercial
4.	Disc	Teflon	
5.	Disc Holder	Brass	ASTM B16 1/4 inch & 1/2 inch
		Bronze	ASTM B62 3/4 inch to 2 inch incl
6.	Pin	Stainless Steel	Commercial
7.	Plug	Bronze	ASTM B16
8.	Retaining Ring	Stainless Steel	Commercial
9.	Disc Nut	Bronze	Commercial

G. Optional check valves for vertical type of installation within steel or copper lines, similar to that of above sub-paragraph G, except vertical lift up-flow, bronze with threaded ends.

H. For check valves within steel piping of 2-1/2 inch size and above, for vertical up-flow applications, Class 250 w.o.g flanged iron body flat style silent check; and for horizontal applications, Class 125 w.o.g flanged iron body horizontal swing check.

I. For check valves within copper piping of 2-1/2 inch through 4 inch size, Class 300 w.o.g bronze for horizontal or vertical installation with solder ends.

2.3 OPERATORS

A. Provide operators for valves 4 inch and larger located in mechanical spaces installed 8 feet or higher above floor.

B. Provide chain lever or chain sprocket operator with sufficient chain to reach within 5 feet of floor.

C. Remote operator accessories are to be by same manufacturer as valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with manufacturer's written instructions, and all valves must be suitable for the service intended.

B. Provide service (isolation) valve at every piece of equipment. Service valves to be positioned in a manner to allow for ease of service and removal of equipment with minimum disruption of the piping system.

C. All shut-off valves in plumbing water systems 2 inch and smaller shall be ball-type.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 22 Sections “Vibration Controls for Plumbing Piping and Equipment” and “Seismic Restraint” for additional requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
1. Pipe hanger and supports.
2. Pipe and equipment anchors.
3. Pipe sleeves.

1.3 QUALITY ASSURANCE

A. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

B. SMACNA.

C. NPFA

1.4 SUBMITTALS

A. Shop Drawings
1. Miscellaneous steel layout. Indicate all point loads where miscellaneous steel is supported by structural members.
2. Brace spacing, layout, connection method and details.

B. Product Data: Catalog cuts and performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Operating and maintenance data.
2. Warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Hangers (Non-Corrosive Environment): Elcen Metal Products Co., B-Line Systems Inc., Carpenter and Paterson Inc., Anvil.

B. Stainless Steel Pipe Hangers (Corrosive Environment): American Stainless & Supply, FM Stainless, National Pipe Hanger Corp.

C. Concrete Anchors: Phillips, Hilti.

D. Insulated Pipe Supports: Pipe Shields Inc., Anvil, Power Piping.

E. Pipe and Equipment Anchors
1. Shop-fabricated.
2. Field-fabricated.

F. Sleeves
1. Shamrock Industries, "Crete-sleeve" plastic hole forms.
2. Proset Systems Inc., "Proset" fire-safe pipe penetrations.
3. Shop for field fabricated.

G. Sleeves, Pre-Manufactured Fire and Smoke Wall Barrier: Pipe Shields, Inc., or equal.

2.2 PIPE HANGERS

A. General
1. Materials, Design and Manufacture: MSS SP-58.
2. Fabrication and Installation: MSS SP-89.
3. Selection and Application: MSS SP-69.
4. Hangers Used Directly on Copper Pipe: Copper or cadmium-plated.
5. All Other Hangers and Channels, Angles, and Supporting Steel: Cadmium-plated or galvanized, except in corrosive environment.
6. All Hanger Rods of Continuous Thread Type: Electro-galvanize or cadmium-plate after threads are cut, except in corrosive environment.
7. Galvanize all structural steel, angles, rods, channels, and hardware that are not provided with a rustproof finish, except in corrosive environment.
8. Corrosive Environment: All hangers, threaded rods, nuts, etc. to be 316 stainless steel.
9. Screw Threads on Hangers and Fittings: Conform to Class 2A and 2B of ANSI B1.1.

B. Pipe Hangers for Insulated and Bare Pipe
1. Insulated Pipe:

MSS	B-Line	ANVIL
1	B3108	260
3	B3144	295

2. Bare Pipe:

MSS	B-Line	ANVIL
1	B3100/02 C	260
3	B3144/46	295
4	B3142	216

3. Hangers for insulated pipe to be oversized to accommodate insulation, protection shields, and/or saddles.

C. Pipe Hangers in Other Situations: See MSS-SP-69.

D. Pipe Hangers on Insulated Lines

1. Pipe Sizes 2 Inch and Less: Use pipe covering shield to protect insulation.
   a. Minimum shield length: 12 inch
   b. Minimum shield thickness: 18 ga.
2. Pipe Sizes 2-1/2 Inch and Larger: Use insulated pipe supports.

E. Hanging Rollers, Cast Iron
1. MSS Type 41.
2. B-Line B3114.
3. Anvil 171.

F. Supporting Roller, Cast Iron
1. MSS Type 44, 45, or 46.
2. B-Line B3117SL, B3117, B3118SL or B3119.
3. Anvil 271, 277, or 274.

G. Insulated Pipe Supports
1. Protect all insulated pipe at point of support by 360-degree pre-insulated pipe supports.
2. Utilize 100 psi, waterproofed calcium silicate fully encased in sheet metal shield for hot pipe applications and cellular glass with ASJ vapor barrier jacket for cold pipe applications.
3. Insert same thickness as adjoining pipe insulation.
4. Use shield length and minimum sheet metal gages indicated:

Pipe Size	Shield Length	Minimum Gage
2-1/2 - 6 inch	6 inch	20
8 - 10 inch	9 inch	16
12 - 18 inch	12 inch	16
20 inch and up	18 inch	16

5. Pipe Supported on Rod Hangers: Pipe Shields, Inc., Models A1000, A2000, A3000, A4000, and A9000.
6. Pipe Supported on Flat Surfaces: Pipe Shields, Inc., Models A1000, A2000, A5000, A6000, and A7000.
7. Pipe Supported on Pipe Rolls: Pipe Shields, Inc., Models A3000, A4000, A5000, A6000, and A8000.

H. Concrete Inserts
1. Continuous Slot Inserts
   a. Anvil Power Struct PS349.
   b. B-Line Figure B32I.
2. Individual Inserts
   a. Anvil Figure 282, or 281.
   b. Do not exceed manufacturer's recommended load on any insert.

I. Beam Clamps
1. B-Line Figure B3054 or B3055.
2. Anvil Figure 133, 218, 228, 292.

J. Attachment to “Z” Type Purlin
1. PHD Figure 290.
2. Michigan No. 315.

K. Attachment to Wood Structure

1. Provide angle clips and lag screws or side beam connectors: PHD figure 920 or 905.
2. Strap-type hangers not acceptable.

L. Pipe Hangers for Stainless Steel Pipe
1. Split ring type or type as recommended by pipe manufacturer.
2. Hanger shall be stainless steel or have a plastic coating to protect pipe from galvanic corrosion.

2.3 PIPE SLEEVES AND SEALANTS

A. Sleeves - General
1. Sleeve all piping passing through walls, floors, roofs, foundations, footings and grade beams sufficient to allow free movement of piping.
2. Box out openings larger than 14 inch diameter.

B. Sleeves, Steel Pipes: Use in following locations:
1. Fire-rated and smoke-rated construction.
2. Structural steel members (when approved by A/E).
3. Floors: Galvanized.
4. Concrete walls.
5. Mechanical rooms, tunnels, and stairwells.
6. Polyethylene hole forms (Crete-Sleeve): Optional use in poured concrete walls and floors.

C. Sleeves for Future Work: Same as for this work.

D. Sleeves in Other Locations: As detailed. If not detailed, use 18 ga galvanized sheet metal or 24 ga spiral duct.

E. Sleeves for Plastic Piping
1. Provide pipe sleeves for all plastic-type piping (PVC, CPVC and polypropylene) at fire-rated assembly and floor slab penetrations.
2. Size sleeves per following schedule:

Pipe Size (In.)	Sleeve Size (In.)	Extension Beyond Barrier (Ft.)
1 or less	3	2
1-1/4 to 2	4	2
3	5	3
4	6	4

3. Extend sleeve listed distance beyond wall or floor on both sides.
4. Insulate plastic pipe with minimum 1 inch thick calcium silicate or 2400 deg F aluminasilica within sleeve length.

F. Sleeves, pre-manufactured fire and smoke wall barrier: Optional, similar to Pipe Shields, Inc.
1. Bare Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
2. Insulated Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
   a. Other insulated pipes: Type CS.
3. Plastic Pipe through Fire Walls and Floors: Type WFB with 1-inch-thick calcium silicate insulation encased in metal sleeve extension 2 ft. either side of fire-rated walls or floor.

G. Sleeve Sizes
1. Length: Ends flush with finished surfaces.
2. Diameter
a. Minimum 3 inch.
b. Minimum 1 inch larger than pipe and pipe insulation.
c. In concrete, 1-1/2 inch larger than pipe.
d. Diameter suitable for construction tolerances and to receive sealant, when indicated.

H. Sealants: Seal annular space around piping.
1. For fire- and smoke-rated floors, walls and partitions: Use UL-listed firestopping material that maintains fire-rated wall and floor integrity.
a. Provide proper material for each typical application as described by manufacturer.
2. Acceptable Manufacturers
a. Base
1) Dow Corning "Fire Stop".
2) Nelson "Flameseal".
3) 3M "Fire Barrier".
4) Pipe Shields Inc., Model WFB, DFB, or QDFB Series.
5) Proset Systems.
3. For Non-Rated Walls and Partitions: Use mineral or glass fiber insulation.
4. For Exterior and Foundation Walls: Use synthetic rubber seals, "Link-Seal" waterproof material or system.

2.4 ROOF MOUNTED PIPE SUPPORTS

A. Roof Pipe Rail Base Assembly
1. Pipe support assembly to include galvanized steel counter flashing, treated wood nailer, galvanized steel slide channel, galvanized continuous threaded rods or reinforced strut, cast iron pipe roller, galvanized washers and nuts, removable retainer bracket.
2. Manufactured by Pate, RPS or equal.
3. Closely coordinate locations for pipe support assembly with joist or beam spacing and maximum limits between supports listed in this specification section.
4. Attach piping to roof pipe rail assembly

B. Roof Pipe Support Assembly
1. Pipe support assembly to include 10-1/2-inch long galvanized steel Unistrut channel bonded into a block of UV-rated, flexible, closed-cell polyethylene foam; assembly to be ERICO Pipe Pier with Eristrut accessories, Hatch Rail Company, or equal..
2. Closely coordinate locations for pipe support assembly with existing joist spacing and maximum limits between supports listed in this specification section.
3. Attach piping to roof pipe support Unistrut using galvanized clamps and screws.

PART 3 - EXECUTION

3.1 GENERAL

A. Structural Considerations
1. Steel or concrete roof/floor system, including slabs or roof deck shall be in place and complete before installation of any mechanical piping system.
2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe Hanger Loading."
3. Do not attach hangers to steel roof deck.

4. Do not attach hangers to bottom of concrete filled floor deck, except by permission of A/E.
5. Attach hangers to beams whenever possible.

B. Install piping systems with approved hangers and supports to prevent sagging, warping and vibration of piping systems. Install pipe hangers and supports to allow for expansion, contraction, and drainage of piping. Place hangers and supports close to valves, vertical riser drops, heavy equipment, specialties, and each piping change of direction. At first elbow of equipment run out piping risers and horizontal piping within ten (10) feet of all circulating basemounted pumps having four (4) inch or larger piping connections, shall have piping at same supported with flexible spring hangers.

C. Connect hanger rods to approved "I" beams or channel clamps, concrete inserts or expansion shields. Provide all concrete inserts and structural members required for the proper support of the piping systems with proper approved distribution of weight.

D. Do not weld to structural steel without special permission of the A/E. Do not use wooden plugs for any form of fastening.

E. Space pipe hangers for horizontal piping as indicated, unless otherwise directed. Provide pipe hangers with the minimum rod sizes shown, complete with full length machined threads, and adjusting and lock nuts.

F. Run piping substantially as shown on the Drawings. Run pipe as directly as possible, avoiding unnecessary offsets and interferences, maintaining maximum headroom and concealed in all rooms or areas, except mechanical equipment rooms, unless otherwise noted. Coordinate exact locations of mains, risers and runouts in the field with the various Trade Contractors and the A/E.

G. Arrange pipe lines to give ample room for pipe insulation. Run piping parallel to or at right angles with the lines of the building.

H. Assemble and install piping without undue strain and stress and with provision for expansion, contraction and structural settlement. Do not cut or notch structural members unless adequate provision is made with the approval of the A/E. Anchors shall be approved by the A/E before they are used.

3.2 PIPE HANGERS AND SUPPORTS

A. For standard steel and copper piping, locate hangers at each change of direction as well as within remaining lengths spaced at or within following maximum limits:

Pipe Diameter	Standard Steel Liquid	Standard Steel Vapor	Copper Liquid	Copper Vapor
1/2 inch	7 ft.	8 ft.	5 ft.	6 ft.
3/4 inch	7 ft.	9 ft.	5 ft.	7 ft.
1 inch	7 ft.	9 ft.	6 ft.	8 ft.
1-1/4 inch	7 ft.	9 ft.	7 ft.	9 ft.
1-1/2 inch	9 ft.	12 ft.	8 ft.	10 ft.
2 inch	10 ft.	13 ft.	8 ft.	11 ft.
2-1/2 inch	11 ft	14 ft.	9 ft.	13 ft.
3 inch	12 ft.	15 ft.	10 ft.	14 ft.

Pipe Diameter	Standard Steel Liquid	Standard Steel Vapor	Copper Liquid	Copper Vapor
4 inch	14 ft.	17 ft.	12 ft,	16 ft.
6 inch	17 ft.	21 ft.	14 ft.	20 ft.
8 inch	19 ft.	24 ft.	16 ft.	23 ft.
10 inch	22 ft.	26 ft	18 ft.	25 ft.

B. For Schedule 40 or Schedule 80 PVC or CPVC piping, locate hangers at each change of direction and space at or within the following maximum limits:

	PVC or CPVC	
Pipe Diameter	**Liquid**	**Vapor**
1/2 - 1 inch	3 ft.	3 ft.
1-1/4 - 2 inch	4 ft.	4 ft.
2-1/2 - 3 inch	4 ft.	4 ft.
3-1/2 - 4 inch	4 ft.	4 ft.
5 - 8 inch	4 ft.	4 ft.

C. Provide a hanger within one (1) foot or less of each horizontal elbow and valves that are above three (3) inches in size. If spacing between horizontal elbows (or plugged tees used as elbows) is less than six (6) feet, provide only one (1) hanger located between the elbows. No hanger size or requirements shall ever be less than the minimum recommended by the Mechanical Contractor's Association of America, Inc.

D. For cast iron pressure piping, space maximum 12 feet o.c.
1. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.

E. For cast iron soil piping, space maximum 10 feet o.c.
1. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.

F. For piping of other materials, space hangers according to manufacturer's recommendations.

G. Pipe Hanger Loading
1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 inch	610 lb.
1/2 inch	1,130 lb.
5/8 inch	1,810 lb.
3/4 inch	2,710 lb.

2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

H. Trapeze Hangers
1. Suspend trapeze hangers from concrete inserts of approved structural clips.
2. Construct trapeze hangers of galvanized angle iron, channels or other structural shapes with flat surfaces for point of support.

I. Vertical Pipe Supports
1. Support all vertical pipe runs in pipe chases at base of riser.

2. Support pipes for lateral movement with clamps or brackets.

J. Concrete Inserts
1. Provide individual or continuous slot concrete inserts for use with hangers for piping and equipment exposed in finished areas, and as required.
2. Provide concrete inserts in time for installation in concrete.

3.3 ANCHORS

A. All connections to the structure shall be sized according to actual applied load plus any seismic vertical component increase.

B. Pipe Anchors
1. Provide as indicated and required to permit complete installation of system.
2. Do not anchor piping to plaster or gypsum wallboard partition walls.
3. Provide anchoring devices at locations indicated.
4. Do not use powder driven fasteners, expansion nails, or friction spring clamps.

3.4 SLEEVES

A. Coordinate location of any opening in structural systems with A/E and other trade contractors.

B. Maintain rating of fire- and smoke-rated construction.

C. Set sleeves plumb or level, in proper position, tightly fitted into the work.

D. Set all sleeves with ends flush with finished wall and ceiling surfaces.

E. Seal around all pipes and use firestopping for all mechanical penetrations through floor slabs, fire rated walls and partitions, and at each floor level in vertical mechanical service shafts.
1. Install firestopping as described in manufacturer's installation instructions.

F. Seal around all sleeves.

G. Fill openings made by others for piping penetrations, with same construction as work opening is in, or construction of equivalent fire or smoke rating.

3.5 MISCELLANEOUS STEEL

A. Piping Contractor (or Plumbing Contractor, as applicable) to provide all miscellaneous steel as required to accommodate pipe supports and hangers.

B. Provide Shop Drawings detailing miscellaneous steel layout and connection to structural members. Indicate all point loads where miscellaneous steel is supported by structural members.

C. All miscellaneous steel to be galvanized steel, except in corrosive environments where stainless steel shall be utilized. Repair galvanized steel at field cuts and connections.

END OF SECTION 220529

SECTION 220548 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 22 Sections “Hangers and Supports for Plumbing Piping and Equipment” and “Seismic Restraint” for additional requirements

1.2 DESCRIPTION OF WORK

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the Drawings and as specified herein to provide complete vibration isolation systems in proper working order.

B. Description of Systems

1. Vibration isolators and hangers.
2. Bases and rails.
3. Isolation pads.
4. Resilient penetration sleeve/seal and lateral guides.
5. Flexible pipe connectors.

1.3 QUALITY ASSURANCE

A. Comply with ASHRAE, ASTM, and AASHO standards.

B. A Practical Guide to Noise and Vibration Control for HVAC Systems, by M.E. Schaffer, and published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA 30329.

C. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate equipment plan dimensions with size of housekeeping pads.

D. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.

E. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the Drawings, without claim for additional payment.

F. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

G. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

1.4 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittals”.

B. Shop Drawings

1. All equipment items specified.
2. Spring Isolators

a. Spring diameter.

b. Deflection.

c. Compressed spring height.

d. Solid spring height.

e. Point location of each isolator.

f. Load at each point.

g. Field static deflection.

h. Horizontal loading and bolt requirements.

i. Indicate all bases and rail clearances.

3. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.

4. Special details necessary to convey complete understanding of the work to be performed.

C. Product Data

1. A complete description of products to be supplied, including product data, dimension, specifications, and installation instructions.

2. Detailed selection data for each vibration isolator supporting equipment, including:

a. The equipment identification mark.

b. The isolator type.

c. The actual load.

d. The static deflection expected under the actual load.

e. Specified minimum static deflection.

f. The additional deflection to solid under actual load.

g. The ratio of spring height under actual load to spring diameter.

D. Samples: Not required for review.

E. Reference Submittals: Not required for review.

F. Contract Closeout Information

1. Operating and maintenance data.

2. Guarantees.

1.5 SPEED AND BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

A. Rotating mechanical equipment shall not operate at speeds in excess of 80% of their true critical speed.

B. Vertical vibration of rotating equipment shall not be greater than the levels indicated. The vibration shall be measured on the equipment or steel frame equipment base when the equipment is mounted on its vibration isolation mounts. If the equipment has an inertia base, the allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment weight alone to the equipment weight plus the inertia base weight.

Equipment Speed	Vibration Displacement (MILS Peak-to-Peak)
Under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
Over 2000 rpm	1

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sound, Vibration and Seismic Control Devices

1. Amber/Booth Co.
2. Korfund Dynamics Corp.
3. Mason Industries, Inc.
4. Peabody Noise Control Inc.
5. Vibration Mountings & Controls, Inc.

B. Sealants for acoustical purposes as described in this section are to be one of the non-setting sealants indicated below or an approved equivalent.

1. Acoustical sealant D.A.P.
2. BR-96 Pecora.
3. Acoustical sealant Tremco.
4. Acoustical sealant U.S.G.

2.2 GENERAL

A. Provide piping and equipment isolation systems as specified and/or as indicated on Drawings.

B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.

1. Provide vibration isolation equipment including mountings, hangers, structural steel bases, welded concrete pouring forms and flexible pipe connectors from a single manufacturer or vibration isolation equipment supplier.

C. Coat all vibration isolation systems exposed to moisture and an outdoor environment as follows:

1. All steel parts to be hot-dip galvanized.
2. All bolts to be cadmium-plated.
3. All springs to be cadmium-plated and neoprene-coated.

D. Coordinate the requirements of this Section with those of Division 22 Section “Seismic Restraint”.

2.3 VIBRATION ISOLATORS AND HANGERS

A. Equipment Mounting Isolators

1. Type 1 Isolators: Double-deflection neoprene mountings.

a. Minimum static deflection: 0.35 inch.

b. Steel top plate and base plate completely embedded in color-coded neoprene stock.

c. Friction pads both top and bottom to eliminate the need for bolting.

d. Where bolting is required, provide bolt holes in base plate and tapped holes in top plate.

e. Mason Industries, Type ND; or Vibration Mountings, Type RD.

2. Type 2 Isolators: Spring-type.

a. Free-standing and laterally stable, without any housings, snubbers, or guides.

b. Provide 1/4-inch neoprene acoustical friction pads between baseplate and support.

c. Provide mounting with leveling bolts that must be rigidly bolted to equipment.

d. Spring diameter: Not less than 0.8 of compressed height of spring at rated load.

e. Spring to have minimum additional travel to solid equal to 50% of rated deflection.

f. Mason Industries, Type SLF; or Vibration Mountings and Controls, Type II, Series A.

3. Type 3 Isolators: Spring-type with vertical limit stop.

a. Equal to Type 2 isolator, except that mountings shall incorporate a resilient vertical limit stop to prevent spring extension during weight changes.

b. Installed and operating heights to be the same.

c. Maintain a minimum clearance of 1/2-inch around restraining bolts and between housing and spring so as not to interfere with spring action.

d. Limit stops to be out of contact during normal operations.

e. Mason Industries, Type SLR; or Vibration Mountings and Controls, Type AWR.

4. Type 4 Isolators: Neoprene wafer pads.

a. Durometer or hardness to suit application.

b. Square waffle pattern on 1/2-inch centers.

c. Standard pads thickness: 5/16 inch; provide optional pad thickness to suit application.

d. Provide natural rubber, hycar, butyl, silicone or other elastomers as prior approved material.

e. Provide type "W" adhesive, both sides, for all non-bolted applications.

f. Mason Industries, Type "W", "WMW", "WML", or "WM"; or Vibration Mountings, Type VM.

B. Vibration Hangers

1. Type 5 Isolators: Steel spring-type hanger.

a. Steel spring and 0.3 inch deflection neoprene element in series.

b. Neoprene element to be molded with a rod isolation bushing that passes through the hanger box.

c. Springs to have a minimum additional travel to solid equal to 50% of rated deflection.

d. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring.

e. Mason Industries, Type 30N; or Vibration Mountings, Type RSH.

2. Type 6 Isolators: Precompressed steel spring-type hanger.

a. Equal to Type 5, except spring is precompressed to rated deflection, so piping or equipment are maintained at a fixed elevation during installation.

b. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.

c. Mason Industries, Type PC30N; or Vibration Mountings, Type RSHP.

3. Type 7 Isolators: Steel spring in neoprene cup-type hanger.

a. Steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of hanger rod.

b. Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.

c. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring.

d. Spring to have a minimum additional travel to solid equal to 50% of rated deflections.

e. Provide an eye bolt on spring end and provision to attach housing to flat iron duct straps.

f. Mason Industries, Type W30; and Vibration Mountings, Type SHP.

4. Type 8 Isolators: Double-deflection neoprene-type hanger.

a. Minimum static deflection: 0.40 inch

b. Elements to be color-coded neoprene stock for easy identification of rated load capacity.

c. Provide hanger for direct attachment to flat iron duct straps.

d. Mason Industries, Type WHD; or Vibration Mountings and Controls, Type RHD.

2.4 BASES AND RAILS

A. Type A: Integral structural steel base.

1. Rectangular, except for equipment which may require "T" or "L"-shaped.

2. Pump Bases for Split-Case Pumps: Provide supports for suction and discharge base ells.

3. Perimeter Members: Beams with a minimum depth equal to 1/10 of the longest dimension of the base.

4. Beam depth need not exceed 14 inches, provided that deflection and misalignment are kept within acceptable limits as determined by the manufacturer.

5. Provide height-saving brackets in all mounting locations to provide a base clearance of 1 inch.

6. Mason Industries, Type WF; or Vibration Mountings and Controls, Type WFB.

B. Type B: Steel rail.

1. Provide steel members welded to height-saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base.
2. Members must be sufficiently rigid to prevent strains in the equipment.
3. Mason Industries, Type ICS; or Vibration Mountings and Controls, Type WFR.

C. Type C: Structural steel and concrete base.

1. Rectangular structural beam or channel concrete forms for floating foundations.
2. Minimum Base Depth: 1/12 of longest dimension of the base, but not less than 6 inches.
3. Base depth need not exceed 12 inches unless specially recommended by base manufacturer for mass or rigidity.
4. Bases for Split-Case Pumps: Large enough to provide support for suction and discharge base ells.
5. Provide minimum concrete reinforcement consisting of 1/2-inch bars or angles welded in place on 6-inch centers running both ways in a layer 1-1/2-inch above bottom, or additional steel as is required by structural conditions.
6. Provide steel members to hold anchor-bolt sleeves when anchor bolts fall in concrete locations.
7. Provide height-saving brackets in all mounting locations to maintain a 1-inch clearance below the base.
8. Mason Industries, Type K (Type BMK); or Vibration Mountings and Controls, Type WPF.

D. Type D: Curb-mounted base.

1. Factory-assembled isolation base that fits over roof curb and under the isolated equipment.
2. Provide extruded aluminum top member to overlap bottom member to provide water run-off independent of the seal.
3. Provide cadmium-plated springs with a 1-inch minimum deflection with 50% additional travel to solid.
4. Spring Diameter: Not less than 0.8 of spring height at rated load.
5. Provide resilient snubbers in corners with minimum clearance of 1/4-inch for wind resistance.
6. Provide a weather seal of continuous closed-cell sponge material both above and below base and a waterproof flexible ductlike EPDM connection.
7. Foam or other contact seals are not acceptable at spring cavity closure.
8. Mason Industries, Type CMAB; or Vibration Mountings and Controls, Type AXR.

2.5 ISOLATION PADS

A. Type IP1: Field-assembled for equipment mounting.

1. Construction: 4-inch-thick, 3,000 psig, concrete pad poured over a 4-inch precompressed glass fiber isolation pad.
2. Glass Fiber Pads
    a. Inorganic inert material with loading capacity up to 500 psig.

b. Covered with an elastomeric coating to increase vibration dampening and to protect media.

3. Concrete Caps

a. 9 sq. ft. in area or less: Reinforced with 6 x 6 x 6 x 6 mesh.

b. Larger than 9 sq. ft. in area: Reinforced with No. 4 rebar 12 inch o.c. each way.

4. Provide concrete caps with beveled edges.

B. Type IP2: Field-assembled for equipment isolation bases.

1. Isolation Bases: Field-assembled concrete pads provided by General Contractor. See Division 03 and structural drawings.

2. Provide isolation bases with an isolation joint to isolate pad from floor slab. See Division 03.

3. Make isolation bases 1 ft. larger each way than equipment mounting base or skid, and size in accordance with approved equipment shop drawings.

4. Make isolation bases minimum 1 ft.- 2 inch thick with top of pad 4 inches above finished floor slab.

5. Reinforce isolation bases as indicated in specifications and drawings.

6. Type IP2 isolation pads provided by General Contractor and coordinated by mechanical work.

2.6 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals are to be field-fabricated from a pipe or sheet metal section that is 1inch larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated.

B. Sleeve to extend 1 inch beyond the penetrated construction on each side. The annular space between the sleeve and the penetrating element to be packed tightly with fire-stop-rated glass fiber or mineral wool to within 1/4 inch of the ends of the sleeve.

C. The remaining 1/4 inch space on each side is to be filled with acoustical sealant to form an airtight seal. The penetrating element is to be able to pass through the sleeve without contacting the sleeve.

D. Alternatively, prefabricated fire-rated sleeves accomplishing the same result are acceptable.

2.7 RESILIENT LATERAL GUIDES

A. These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising ducts or pipes.

B. Resilient lateral guides shall be one of the following products:

1. Mason Industries, Type ADA.

2. Peabody Noise Control, Type RGN.

3. Vibration Mounting & Controls, Type MDPA.

4. Approved equal guides (custom made) by Amber/Booth or Korfund Dynamics.

2.8 FLEXIBLE PIPE CONNECTORS

A. Spherical Rubber Connector

1. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners, and Kevlar tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable.
2. Sizes 2-inches and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16 inches to 24 inches may be single sphere.
3. Sizes 3/4 inch to 1-1/2 inch may have threaded two-piece bolted flange assemblies, one sphere and cable retention.
4. Connectors shall be rated at 250 psi up to 170 deg F with a uniform drop in allowable pressure to 215 psi at 250 deg F in sizes through 14 inches. 16 inches through 24 inches single sphere minimum ratings are 180 psi at 170 deg F and 150 psi at 250 deg F. Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1.
5. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.
6. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods.
7. If control rods are used, they must have 1/2-inch thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi maximum on the washer area.
8. Submit two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.
9. All expansion joints shall be installed on the equipment side of the shut-off valves. Expansion joins shall be SAFEFLEX SFDEJ, SFEJ, SFDCR, or SFU and Controls Rods CR as manufactured by Mason Industries, Inc. or approved equal.

B. Flexible Pipe Hoses: Type FPH, stainless-steel-type.

1. Stainless steel braid and carbon steel fittings.
2. Sizes 3-inch and larger: Flanged.
3. Sizes 2-1/2-inch and less: Male nipples.
4. Mason Industries, Type BSS; or Vibration Mountings, Type MFP.

PART 3 - EXECUTION

3.1 APPLICATION

A. General

1. Install all vibration control equipment in accordance with manufacturer's installation instructions and as specified.
2. All vibration control equipment shall be selected as specified and sized in accordance with weight distribution, pull or torque imposed by shop-drawing-approved equipment being isolated.
    a. Minimum static deflections may be revised subject to prior approval.

b. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected on the basis of rated deflection are not acceptable and will be disapproved.

1) Provide revised vibration control equipment to match revised or substituted equipment.

3. Locations of all vibration isolation equipment shall be selected for ease of inspection and adjustment as well as for proper operation.

a. All vibration isolators to be aligned squarely above or below mounting points of the supported equipment.

b. Isolators for equipment with bases to be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.

c. Locate isolators to provide stable support for equipment, without excess rocking. Consideration to be given to the location of the center of gravity of the system and the location and spacing of the isolators.

d. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.

e. Hanger rods for vibration isolated support to be connected to structural beams or joists, not from the floor slab between beams and joists. Provide intermediate support members as necessary.

f. Vibration isolation hanger elements to be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.

g. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Isolator deflections must be the largest determined by the provisions for pipe isolation. Do not mix isolated and non-isolated pipes on the same trapeze.

h. No pipes or equipment are to be supported from other pipes or equipment.

i. Resiliently isolated pipes are not to contact the building construction or other equipment.

j. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting pipes.

B. Major Equipment

1. Unless otherwise shown or specified, all floor-mounted major equipment shall be set on 4-inch-high concrete housekeeping pads. See architectural or structural Drawings for details.

2. Flexible pipe connections, are to be installed at all pipe connections to vibration isolated equipment in the positions shown on the Drawings.

C. Pipes

1. All piping within three support positions of a connection to a pump, compressor engine, or other rotating type equipment piping is to be supported by means of vibration isolation mounts, resilient pipe guides, and resilient penetration sleeve/seals.

2. Where lateral support of pipe risers is required within the specified limits, this is to be accomplished by use of resilient lateral supports.

3. Pipes within the specified limits (three support positions) that penetrate the building construction are to be isolated from the building structure by use of resilient penetrating sleeve/seals.
4. Drain piping connected to vibration isolated equipment shall not contact the building structure or other non-isolated system unless it is resiliently mounted.

3.2 VIBRATION ISOLATORS

A. Use Type 1 isolators for equipment mounted on floors other than grade-supported floor slabs.
   1. Air compressors, 3 hp or less.
   2. Vacuum pumps, 3 hp or less.
   3. Minimum static deflections, 0.35 inch.
B. Use Type 2 isolators for equipment mounted on floors other than grade-supported floor slabs.
   1. Air compressors, 15 hp and larger.
   2. Vacuum pumps, 15 hp and larger.
   3. All pumps, 30 hp and larger.
   4. Minimum static deflections, 1.5 inch.
C. Use Type 3 isolators for equipment mounted on floors other than grade-supported floor slabs.
   1. All boilers.
   2. Minimum static deflections, 1.5 inch.
D. Use Type 4 isolation pads for equipment mounted on grade supported floor slabs.
   1. Air compressors.
   2. Vacuum pumps.
   3. Boilers.
   4. Minimum static deflections, 0.3 inch.
E. Use Type 5 vibration hangers for suspended equipment.
   1. Individual runs of piping, 3-inch and smaller.
   2. In-line pumps, 2 hp and smaller.
   3. Minimum static deflections, 0.3 inch.
F. Use Type 6 vibration hangers for suspended equipment.
   1. Trapeze-type pipe hangers.
   2. Individual runs of piping, 4 inch through 6 inch.
   3. Inline pumps, 3 hp through 5 hp.
   4. Minimum static deflection, 1.5 inch.
G. Use Type 6 or Type 7 vibration hangers for suspended equipment.
   1. Trapeze-type pipe hangers.
   2. Individual runs or piping, 8 inch and larger.
   3. In-line pumps, 7-1/2 hp and larger.
   4. Minimum static deflection, 2.5 inch.

3.3 BASES AND RAILS

A. Use Type C concrete platforms for equipment mounted on floors other than grade supported floor slabs.

1. Air compressors, 15 hp and larger.
2. Vacuum pumps, 15 hp and larger.
3. All base-mounted pumps, 30 hp and larger.

3.4 ISOLATION PADS

A. Use Type IP1 isolation pads for equipment mounted on floors other than grade-supported floor slabs.

1. Air compressors, 5 hp through 10 hp.
2. Vacuum pumps, 5 hp through 10 hp.
3. All base-mounted pumps, 25 hp and less.

B. Use Type IP2 isolation pads for equipment mounted on grade.

1. Boilers.
2. Pump groups where one pad serves two or more pumps.

3.5 FLEXIBLE PIPE CONNECTIONS

A. Use Type FPC flexible connectors in piping systems.

1. Pump Suction and Discharge
    a. Exception: When two or more mechanical grooved pipe (Victaulic type) couplings are used at each pump suction or discharge side.
2. Building expansion joints.

B. Use Type FPH flexible hose in piping systems.

1. Air compressor discharge piping.
2. Vacuum pump suction piping.
3. Fuel oil pump suction and discharge piping.

C. Install flexible pipe connections and flexible hoses on equipment side of equipment isolation valves.

D. Provide flexible connectors and flexible hose to suit the application.

1. Indicate specific applications on shop drawings.

3.6 HORIZONTAL PIPE ISOLATION

A. First three pipe hangers in the main lines near mechanical equipment shall be Type 8 isolators.

B. Horizontal runs in all other locations throughout the building shall be isolated by Type 7 isolators.

C. Floor supported piping shall rest on Type 3 isolators.

D. All Type 7 isolators, or the first three Type 8 mounts, as noted above, will have same static deflection as specified for the mountings under the connected equipment.

E. If piping is connected to equipment located in basements and hangs from ceiling under occupied spaces, the first three hangers shall have 0.75 inch deflection for pipe sizes up to and

including 3 inch; 1.5 inch deflection for pipe sizes up to and including 6 inch; and 2.5 inch deflection thereafter.

F. All other hangers and mounts will have a minimum steel spring deflection of 0.75 inch.

G. Locate hanger as close to overhead supports as is practical.

END OF SECTION 220548

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Piping identification.
   2. Valve identification.
   3. Equipment identification.

1.3 QUALITY ASSURANCE

A. Piping System Identification: ANSI A13.1-2015, "Scheme for the Identification of Piping Systems."

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Manufacturer's cut sheets and/or literature.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information: Valve chart showing valve numbers, type, and location.

PART 2 - PRODUCTS

2.1 PIPE MARKERS

A. Conform to ANSI A13.1-2015.
   1. Pressure-sensitive vinyl (self-sticking) material.
   2. Mechanically Fastened Type: Snap-on or strap-on.
      a. For dirty greasy, oily pipe where pressure-sensitive markers may not perform satisfactorily.
   3. Provide with direction of flow arrows.

4. Size of Letters Legend

Outside Diameter of Pipe or Pipe Covering	Length of Color Field	Size of Letters and Arrows
3/4 to 1-1/4 inch	8 inch	1/2 inch
1-1/2 to 2 inch	8 inch	3/4 inch
2-1/2 to 6 inch	12 inch	1-1/4 inch
8 to 10 inch	24 inch	2-1/2 inch
Over 10 inch	32 inch	3-1/2 inch

2.2 VALVE TAGS

A. Brass or Anodized Aluminum Type
1. Brass: Minimum 19 ga, polished, 1-1/2-inch diameter with following lettering:
a. Service: 1/4 inch stamped black filled letters.
b. Valve numbers: 1/2 inch stamped black filled letters.
2. Aluminum: 2-inch diameter, 0.032 inch thick, with following lettering:
a. Service: 1/4 inch engraved letters.
b. Valve numbers: 1/2 inch engraved letters.

B. Valve Tag Fasteners: 4-ply 0.018 copper or monel wire meter seals, brass "S" hooks or No. 16 brass jack chain.

2.3 EQUIPMENT NAME PLATES

A. 1/16-inch rigid plastic "Setonply," "Emedolite," or bakelite with 4 edges beveled, or engraved aluminum with black enamel background and natural aluminum border and letters.
1. Two 3/8-inch mounting holes.
2. Lettering size: Minimum 1/2-inch high.
3. Fasteners: Commercial quality, rust-resisting nuts and bolts with backwashers and self-tapping screws or rivets.

2.4 CHART AND DIAGRAM FRAMES

A. Extruded aluminum with plexiglass or glass windows.

2.5 ACCEPTABLE MANUFACTURERS

A. Pipe, Valve, and Equipment Markers
1. Craftmark Identification Systems.
2. W. H. Brady Co.
3. EMED Company, Inc.
4. Kolbi Industries, Inc.
5. 3M Co.
6. Seton Name Plate Corp.

PART 3 - EXECUTION

3.1 VALVE AND EQUIPMENT IDENTIFICATION

A. Designate all equipment and valves by distinguishing numbers and letters on charts and/or diagrams.
1. Tag and locate following equipment items:
a. Valves.

b. All items indicated on drawing equipment schedules.

B. Install tags on all devices with numbers and letters corresponding to charts.

C. Fasten tags securely to devices with tag fasteners in manner for easy reading.

D. Attach equipment nameplates in conspicuous location on item of equipment or apparatus such as starters, pumps, and control panels.
1. Secure nameplates with self-tapping screws, or nuts and bolts.

E. For unsuitable conditions, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

F. Furnish 4 charts including device number, location (room number, department) and purpose.
1. Mount 1 chart in frame and secure on wall in location directed by Owner.
2. Include remaining 3 sets in "Operation and Maintenance Manuals."

G. Provide all devices located above ceilings with additional identification.
1. Use access panel markers (metal-tack-style) for acoustical tile ceilings, or engraved plastic style, 3/4 inch square, for mounting on panel door.
2. Coordinate with Owner on identification method and color codes.

3.2 PIPE IDENTIFICATION

A. Soil, waste, and vent piping do not require color coded paint or bands.

B. Locate pipe markers as follows:
1. Next to each valve and fitting, except on plumbing fixtures and equipment.
2. At each branch or riser take-off.
3. At each passage through walls, floors, and ceilings.
4. At each pipe passage to underground.
5. On all horizontal pipe runs every 20 ft., at least once in each room and each story traversed by piping system.
6. Identify piping contents, flow direction, supply and return.

C. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

D. Where supplementary color identification of medical gas piping is used, paint in accordance with gases and colors indicated in CGA Pamphlet C-9.

3.3 SERVICE ABBREVIATIONS

A. General
1. DCW Domestic Cold Water
2. DHW Domestic Hot Water Supply (130 degrees F)
3. DHWR Domestic Hot Water Recirculating

END OF SECTION 220553

SECTION 220561 - PREPARATION OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CLEANING AND PREPARATION FOR SERVICE

A. Flushing Mains. Immediately upon completion of the water distribution system, test valves to ensure their full opening. Flush the system as follows: Open valve and permit the flow to continue until the water runs clear. Repeat the operation at the next valve and proceed in order to the valve farthest from the source of supply. Use outlets in building to flush the upper ends of mains and service lines. During such flushing operation, the A/E may test the flows from valves and, before final acceptance of the work, make further tests of flows to ascertain that lines are clear.

B. Interior and Exterior Sterilization of Water Distribution System. After the water distribution system has been flushed, sterilize the system by the following or other, more rigid methods satisfactory to the A/E and the State and Local Plumbing Authorities.
   1. Introduce chlorine or a solution of calcium or sodium hypochlorite, filling the lines slowly and applying the sterilizing agent at a rate of 50 parts per million of chlorine, as determined by residual chlorine tests at the ends of the lines. Open and close all valves and hydrants while chlorinating the system.
   2. After sterilization agent has been applied for 24 hours, test for residual chlorine at the ends of the lines. If less than 25 ppm is indicated, repeat the sterilization process.
   3. When tests show at least 25 ppm of residual chlorine, flush the system until all traces of the chemical are removed.

C. The Owner reserves the right to require testing of the water again at any time prior to final acceptance of the work and, if found bacteriologically unsafe, to require the Contractor to rechlorinate the system until the water is proven equal to that supplied by the public system.

3.2 SANITARY WASTE/VENT AND STORM DRAINAGE SYSTEMS

A. Test systems as recommended by Local and State Plumbing Inspection Authorities.

3.3 OPERATIONAL TEST

A. Upon completion of and prior to acceptance of the installation, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:
   1. Time, date, and duration of test.
   2. Water pressure at the most remote and the highest fixtures.
   3. Operation of each fixture and fixture trim.

4. Operation of each valve, hydrant, and faucet.
5. Pump suction and discharge pressures.
6. Temperature of each domestic hot water supply.
7. Operation of each floor and roof drain by flooding with water.
8. Operation of each vacuum breaker and backflow preventer.
9. Complete operation of each water pressure booster system (when applicable), including pump start pressure and stop pressure.

END OF SECTION 220561

SECTION 220593 - PLUMBING SYSTEMS TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work Includes
1. Furnishing all labor, materials, tools, equipment, and services to test, balance and adjust all mechanical systems as indicated, in accord with provisions of Contract Documents.
2. Complete coordination with work of all other trades.

B. Test, balance, and adjust following mechanical systems:
1. Domestic Circulating water systems, Hot Water.

1.3 QUALITY ASSURANCE

A. Agency Qualifications: Independent balance and testing agency, member of the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).

B. Balancing Standards: AABC requirements and recommendations.

1.4 RESPONSIBILITIES OF TESTING AND BALANCING AGENCY WORK

A. Schedule work with trades involved.

B. Check, adjust, and balance system components to obtain optimum conditions for function and operation of system.

C. Evaluate operation of systems and advise installer of necessary adjustments and corrective measures.

D. Balance to within plus or minus 10% of set point of balancing valves or pumps.

E. Prepare and submit test reports.

1.5 RESPONSIBILITIES OF PLUMBING CONTRACTOR’S WORK

A. Startup systems and keep in correct operation during balancing operations.

B. Clean strainers prior to balancing system.

C. Make personnel accessible to provide necessary adjustments and corrections to systems as directed by balancing agency.

D. Maintain accessibility to test locations and devices requiring adjustment.

E. Provide to the Test and Balance Agency a complete set of approved Shop Drawings and submittals and a posted set of Plumbing Drawings, indicating any and all changes to the Contract Documents.

1.6 JOB CONDITIONS

A. Balance at time directed by Owner.

1.7 GUARANTEE

A. Provide extended warranty of 90 days, after completion of test and balance work, during which time the CM/Owner may, at their discretion, request recheck or resetting of any equipment or system which is not performing satisfactorily. Provide technicians to assist as required in making such tests.

1.8 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Not required for review.

C. Samples: Not required for review.

D. Reference Submittals: Qualifications of balancing agency and sample report forms.

E. Contract Closeout Information
   1. Balancing Reports
      a. Use forms similar to AABC latest edition.
      b. Report to include the following:
         1) All specified data including balancing valve location and gpm.
         2) All equipment nameplate information.
         3) AABC equipment data sheets.
         4) Pump curves.
         5) Temperature readings leaving water heater or thermostatic mixing valve and at recirculation pump.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Accurately calibrate and maintain all test instruments in good working order.
   1. If requested, conduct tests of instruments in presence of Owner.

B. If requested, conduct balancing tests in presence of Owner.

C. Do not begin balancing until system(s) have been completed and are in good working order.

D. Record all inspections, tests, and adjustments.

3.2 WATER BALANCE PROCEDURE

A. Open all valves to full open position.

B. Checks pump rotation.

C. Check expansion tanks to determine they are not air-bound.

D. Check for installation and proper operation of manual air vents.

E. Check hot water supply temperatures and return water temperatures at mains. Reset to correct design temperatures.

F. After completing balancing valve to set points noted on drawings, test hot water pressures and flows at the pumps and re-adjust if required.

G. Check the following in domestic hot water systems.
1. Leaving water temperature at water heater.
2. Leaving water temperature at thermostatic mixing valve.
3. Pressure of domestic cold water at water service entrance.
4. Pump operating suction and discharge pressures and final total dynamic head.
5. Water metering device readings.

H. List all mechanical specifications of pumps.

I. Record nameplate and actual operating amperages of pump motor.

3.3 SPARE PARTS

A. Provide portable readout kit and specific manufacturer's balancing wheel (charts) for Owner's use.

3.4 OPERATING TEST

A. After systems are balanced, conduct operating test of not less than 8 hours' duration for domestic hot water systems to demonstrate to satisfaction of the Owner that systems comply with requirements of plans and specifications, and that all equipment and controls are functioning properly.

END OF SECTION 220593

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to;
   1. Pipe insulation.
   2. Equipment insulation.
   3. Insulation adhesives, mastics and caulking.

B. Definitions
   1. Concealed Insulated Surfaces: Piping and equipment in walls, partitions, floors, pipe chases, pipe shafts, duct shafts, sealed alleyways, and above suspended ceilings.
   2. Exposed Insulated Surfaces: Piping and equipment located in mechanical rooms, tunnels, and rooms without suspended ceilings.

1.3 QUALITY ASSURANCE

A. Comply with fire and smoke hazard ratings indicated.
   1. Test by procedure ASTM E84, NFPA 255, and UL 723.
   2. Accessories such as adhesives, mastics, cements, tapes, and glass fabric, same or better component ratings.
   3. Following are rating requirements:
      a. Flame spread (maximum): 25
      b. Smoke developed (maximum): 50
   4. Properly identify products and/or their shipping cartons for flame and smoke ratings.
   5. Where prohibited by code or local ordinances, do not use elastomeric-type insulation anywhere within ceiling plenum return air systems.

1.4 SUBMITTALS

A. Shop Drawings: Submit schedule indicating service, application, thickness and finishes.

B. Product Data
   1. Manufacturer's cut sheets and literature.
   2. Performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Close-Out Information
   1. Manufacturer's installation, maintenance, and painting data.
   2. Guarantees.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Glass Fiber Pipe Covering, Calcium Silicate, and Thermal Insulating Wool: Manville, Owens-Corning, Manson, Knauf.

B. Fire-Retardant Adhesive: Manville, Benjamin Foster, 3M, Insul-Coustic, Childers.

C. Lagging Adhesive: Manville, Benjamin Foster, Borden, Insul-Coustic.

D. Elastomeric Pipe Insulation and Equipment Covering: Armstrong Armaflex, IMCOA, Imcolock, Ultrafoam.

E. Insulated Fitting Covers: Manville, Certain-Teed, Knauf.

F. Insulation Caulking: Dow No. 11.

2.2 GENERAL

A. Provide fire and smoke hazard ratings as indicated for entire composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation).

B. Do not use material that exceeds specified flame and smoke ratings.

C. Use permanent treatments to jackets or facings to impart specified fire ratings.

D. Use of water soluble treatments is prohibited.

E. At Hangers and Bracing: See Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment”.

2.3 PIPE INSULATION, NON-FLEXIBLE

A. Pipe Insulation, Non-flexible
1. O-C fiberglas ASJ/SSL-II pipe insulation with all service jacket (ASJ).
2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75 deg F.
3. Apply to the following piping in thickness indicated:
   a. (Domestic) potable & non-potable cold water:
      1) Runouts to fixture (<12 feet).....1/2 inch
      2) 1-1/4 inch and smaller.....1/2 inch
      3) 1-1/2 and larger.....1 inch
   b. Domestic hot/recirculating water (thru 140 deg F):
      1) 1-1/4 inch and smaller…….. 1 inch
      2) 1-1/2 inch and larger……...1-1/2 inch
   c. Domestic hot/recirculating water (141 deg F thru 160 deg F):
      1) 1-1/4 inch and smaller.....1-1/2 inch
      2) 1-1/2 inch and larger.....2 inch
   d. Horizontal rain leaders (including 24 inch up and down from horizontal and up to underside of roof deck):
      1) All sizes.....1 inch

2.4 PIPE INSULATION, FLEXIBLE

A. Pipe Insulation, Flexible
1. Armstrong self-seal AP Armaflex flexible elastomeric pipe insulation.

2. Thermal conductivity (K value): Not greater than 0.27 at mean temperature of 75 deg F.
3. Apply to following piping in thickness indicated:
   a. Domestic (potable) cold water:
      1) 2 inch and smaller.....1/2 inch
   b. Waste piping from water coolers and drinking fountains:
      1) All sizes.....1/2 inch
   c. Waste piping from lab sinks to main stacks:
      1) All sizes.....1/2 inch

2.5 INSULATION FOR HOT EQUIPMENT

A. Insulation For Hot Equipment (Domestic Water Systems)
1. O-C Type 703 fiberglass board, 3.0 pcf, FRK facing.
2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75 deg F.
3. Apply to following equipment in 2 inch thickness:
   a. Domestic hot water instantaneous heaters

2.6 INSULATION FOR DOMESTIC WATER HEATER STORAGE TANKS

A. Insulation for Domestic Water Heater Storage Tanks
1. O-C Type 703 fiberglass board, 2 inch thickness, 3.0 pcf density, unfaced.
2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75deg F.
3. Apply to all domestic water heater storage tanks, except when specified as factory-insulated.

2.7 INSULATION FOR COLD EQUIPMENT

A. Insulation for Cold Equipment
1. Armstrong Armaflex II sheet insulation; 1-1/2 inch material installed in 2 layers with joints staggered.
2. Thermal conductivity (K value): Not greater than 0.27 at mean temperature of 75 deg F.
3. Apply to following equipment in thickness indicated:
   a. Domestic water meter.....3/4 inch
   b. Roof drain bodies.....3/4 inch

2.8 INSULATION FASTENERS

A. Insulation Adhesive: Childers CP-82.

B. Insulation Mastic: Childers CP-30.

C. Insulation Caulking: Dow No. 11.

PART 3 - EXECUTION

3.1 APPLICATION - GENERAL

A. Do not insulate piping until satisfactory completion of required pressure tests.

B. Do not insulate heat-traced piping until cable installation is complete and a megohmeter test has been passed.

C. Apply insulation to clean, dry surfaces with pipe surfaces at room temperature.

D. Butt insulation firmly together with longitudinal and end joints sealed with compatible jackets, facings and adhesives as specified.

E. Apply adhesives, mastics and coatings per manufacturer's recommendations and as specified.

F. On cold surfaces where vapor barrier jackets are used, apply insulation with a continuous, unbroken vapor seal.
   1. Adequately insulate and vapor seal hangers, supports, and anchors that are secured directly to cold surfaces to prevent condensation.

G. Continue insulation through sleeves and wall and ceiling openings except insulation shall not continue through fire-rated (2-hour or greater) partitions, walls, floor-ceiling systems.

H. Insulate all fittings, valve bodies, flanges and other pipeline accessories.

I. At hangers and bracing, install in accord with Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment”.

J. Contractors shall consult manufacturer's Technical Bulletins for detailed information on safety precautions in using all insulation products, polyurethanes, polyisocyanurates, and related materials. The data shall describe fire and other risks, safety in handling, toxicity, threshold limit values, physiological effects of inhalation and eye and skin contact, incompatibilities and other essential information regarding use. Obtain six (6) copies for distribution and use at jobsite and for submittal with shop drawing submittals.

3.2 APPLICATION OF NON-FLEXIBLE PIPE INSULATION

A. On piping, install with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge on hot piping.
   1. On cold piping, use self-sealing lap system or adhesive applied to both surfaces per manufacturer's recommendation.
   2. Do not staple cold piping.
   3. Butt adjoining sections of insulation tightly together and continue jacket by installing self-adhering butt strips over entire circumferential joint.

B. Installation of Insulation of Fittings
   1. For pipe sizes 2 inches and smaller, finish with mineral fiber cement to thickness of adjoining pipe insulation.
   2. Over 2 inches, insulate with mitered pipe insulation segments or preformed fiberglass fittings secured with vinyl faced insulation strapping tape or 20 ga galvanized annealed wire and finished with one coat of mineral fiber cement.
   3. After cement is dry, finish with Glass Fab and seal with Foster 30-36 adhesive.
   4. Prefabricated fitting covers approved for use at pipe fittings may be used instead of finishing method outlined above.
   5. Install in accordance with manufacturer's recommendations.

C. Cover all insulated piping exposed to weather with additional jacket of 0.016-inch smooth aluminum with moisture barrier.
   1. Apply aluminum jacket with 0.020-inch x 3/8-inch aluminum bands on 9-inch centers, minimum 2-inch lap joint.
   2. Protect fittings, valves, and specialties exposed to weather in like manner.
   3. Contractor option: Use Ceel-Co 300 Series plastic jacketing applied per manufacturer's recommendations.

D. Reinforce jackets on insulated piping in mechanical rooms and central plant less than 8 ft. above floor.
   1. Cover with 0.030 inch PVC jacket conforming to 25-50 fire requirements.

3.3 APPLICATION OF FLEXIBLE PIPE INSULATION

A. Install tubing wherever possible by slipping material over piping. Otherwise, slit pipe insulation, tightly butt ends and seal butt joints and slit seams with suitable adhesive.

B. Insulate fittings and valve bodies with segments cut from pipe insulation. Apply with adhesive.

C. Insulate piping at hanger points with fiberglass material protected with metal saddles.

3.4 APPLICATION OF INSULATION ON HOT EQUIPMENT

A. Install insulation with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge.

B. Butt adjoining sections of insulating tightly together and continue jacket by installing self-adhering butt strips over entire joint.

C. Insulate flanges and fittings with mineral fiber cement.

D. Finish body with 0.016-inch aluminum jacket. Reinforce end and irregular surfaces with Glass Fab embedded in 2 coats of Foster 30-36 adhesive.

3.5 APPLICATION OF INSULATION ON DOMESTIC WATER HEATER STORAGE TANKS WHEN TANKS NOT FACTORY-INSULATED

A. Install insulation with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge.

B. Butt adjoining sections of insulating tightly together and continue jacket by installing self-adhering butt strips over entire joint.

C. Insulate flanges and fittings with mineral fiber cement.

D. Finish body with 0.016-inch aluminum jacket. Reinforce end and irregular surfaces with Glass Fab embedded in 2 coats of Foster 30-36 adhesive.

3.6 APPLICATION OF INSULATION ON COLD EQUIPMENT

A. Apply with Armstrong 520 adhesive covering entire surface as well as back of insulation.

B. Coat all butt edges and press firmly together with 1/8-inch overlay pressure.

C. Apply two (2) coats of Armstrong Armaflex finish over sheet surfaces.

END OF SECTION 220700

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. This Section applies to potable cold water, hot water, hot water recirculation piping.

1.3 EQUIPMENT BY OTHERS

A. Include all necessary roughing-in and final equipment connections by plumbing trade as required.

B. Wherever equipment is furnished and set in place under Work of another Section or by Owner, they shall furnish detailed Drawings and exact rough-in dimensions and locations at the Site.
   1. Information shall be furnished sufficiently in advance to allow proper installation of all required services.
   2. If the Owner does not provide information sufficiently in advance, the Owner shall provide compensation for additional costs incurred due to changes in location of required services.
   3. This Division shall include all required service rough-ins and final connections to the equipment.

1.4 QUALITY ASSURANCE

A. General
   1. Provide all supervision, labor, tools, materials, equipment, accessories and specialties necessary to completely install, clean and test the plumbing systems.
   2. All materials shall be free from defects impairing strength and durability and shall be of the best quality for the indicated purposes. All Work shall have structural properties sufficient to solely sustain or withstand strain and stresses to which it is normally subjected; all Work shall be true to detail.

B. Codes and Standards (Division 22 Section “Common Work Results for Plumbing” Listings and the following).
   1. Plumbing installation shall be in accordance with the state and local plumbing code, and all other codes having jurisdiction.
   2. American Standard Code for Pressure Piping ANSI B31.1
   3. National Association of Corrosion Engineers
   4. American National Standards Institute (ANSI)
   5. American Society of Mechanical Engineers (ASME)
   6. American Society for Testing and Materials (ASTM)
   7. American Water Works Association
   8. Manufacturer's Standardization Society of the Valve and Fitting Industry
   9. Plumbing and Drainage Institute
   10. State or local Plumbing Code, as applicable.
   11. State or local Building Code, as applicable.

12. 42 USC 300G: The Reduction of Lead In Drinking Water Act.

C. Material Standards
1. ASTM B32-04: Specification for Solder, Metal Sizes.
2. ASTM B42-02: Specification for Seamless Copper Pipe, Standard Size.
3. ASTM B75-02: Specification for Seamless Copper Tube.
4. ASTM B88-03: Specification for Seamless Copper Water Tube.
5. ASTM B251-02: Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
6. ASTM B302-02: Specification for Threadless Copper Pipe.
7. ASTM A53-04a: Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.
8. AWWA C651-05: Standard for Disinfecting Water Mains.

1.5 SUBMITTALS

A. Shop Drawings
1. Piping Systems: Submit piping layout drawings for domestic cold water, hot water, and hot water recirculation piping systems prior to installation.

B. Product Data: Catalog cuts.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Valve Chart (See Division 22 Section “General Duty Valves for Plumbing Piping”)
a. Prepare valve chart for review prior to installation.
2. Test reports.
3. Final approvals by authorities having jurisdiction.

1.6 HANDLING, DELIVERY, AND STORAGE

A. General
1. Handling, delivery, and storage shall be in accordance with the manufacturer's recommendations.
2. No extra cost shall be charged the Owner for handling, delivery, or storage.
3. In no case shall the pipe or appurtenance be dumped, dropped, or thrown.

1.7 JOB CONDITIONS

A. Coordinate the exact location of this work with the work of other trades prior to fabrication and installation. Verify all dimensions and elevations. Provide additional offsets and section of piping as required to meet job conditions. Coordinate with and review all related Drawings of all trades prior to start of work.

PART 2 - PRODUCTS

2.1 PIPING

A. General
1. The outside of all piping and fittings shall bear the Manufacturer's standard marking for type, pressure, etc.

2. The A/E does not guarantee the accuracy of the figure numbers as listed.
3. Use copper piping for domestic (potable) water system piping, except where noted on the Drawings to use CPVC piping.

B. Pipe - General
1. All pipe and fittings shall be equal to or better than the grade specified.
2. All piping material shall be new and free from defects and shall be subject to standard mill test before being shipped.
3. Pipe shall be labeled.
4. Fittings and valves shall have the Manufacturer's name or trademark legibly raised or cut into each piece.
5. All pipe shall be cut off even and reamed full bore. Threads shall be cut smooth, true and to full standard size. Piping shall be installed clean of chips, burrs or oil.
6. No salvaged or used pipe shall be used without the written approval of the A/E or Owner. Wherever such approval is given, recut the ends of the pipe, square, cut new threads on screwed pipe, and thoroughly clean the pipe of all rust, dirt, scale and foreign matter before installation.

C. Pipe 4-inch Size and Smaller
1. Pipe: Copper tube, seamless, type L hard temper, ASTM B-88, above ground, and type K soft temper, 2-inch and smaller, below ground.
   a. Fittings: Cast brass or wrought copper, solder type, ASTM 75, ANSI B16.22, or B16.18.
   b. Joints: Soldered, 95-5 tin-antimony solder above ground, and silver solder below ground.
   c. Unions: Sweat-end, 150 lb. cast brass, ground joint.
   d. Mechanically formed tee connections and couplings, such as T-drill, are acceptable. All joints shall be brazed with brazing material conforming to AWS A5.8 Classification BCUP-3 or BCUP-4.
   e. Copper press fittings may be used as an option, per ASTM B16.18 or ASTM B16.22. O-rings shall be EDPM. Copper press fittings to be equal to ProPress as manufactured by Rigid Tool/Viega or Nibco Press System.
   f. For 2-1/2-inch through 4-inch Type L copper piping above ground, the use of a grooved piping system including couplings, reducers, elbows, tees, and flange adaptors that are certified and approved by BOCA, IAMPMO, SBCCI, and UL for up to 300 psig working pressure and up to 230 deg F operating temperature is acceptable. All copper piping to be roll grooved.
2. Pipe: Stainless steel, Type 316, ASTM A312, aboveground, cold water only.
   a. Fittings: Stainless steel, Type 316.
   b. Joints: Welded autogenously or with approved filler material listed in ASTM A312 or mechanical joints in accordance with manufacturer's instructions.
   c. Unions: Mechanical joint of the compression or mechanical sealing type, or dielectric fitting.
3. Pipe: CPVC, ASTM F 441/F 441M, Schedule 40 and Schedule 80; ASTM D 2846, Schedule 40.
   a. CPVC Socket Fittings: ASTM F 438 for Schedule 40, and ASTM F 439 for Schedule 80.
   b. CPVC Threaded Fittings: ASTM F 437, Schedule 80.
   c. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
      1) CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      2) Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   d. Plastic-to-Metal Transition Fittings

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a) Charlotte Pipe and Foundry Company.
b) Harvel Plastics, Inc.
c) Spears Manufacturing Company.
2) Description: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end

D. Pipe 5-inch Size and Larger
1. Pipe: Galvanized steel, Schedule 40, ASTM A-120 or A-53.
a. Coating: Hot-dipped galvanized inside and outside.
2. Fittings
a. Threaded, galvanized, 125 lb. SWP, ANSI B16.4.
b. Galvanized flanged, 125 lb. C I, ANSI B16.1.
3. Joints: Threaded, galvanized 125 lb. C I, ANSI B16.1, Victaulic, Aeroquip or Stockham.
4. Unions: Same as joints.
5. Gaskets: 1/16-inch thick rubber. Type of gaskets selected shall protect ends of galvanized pipe and be as recommended by piping and joint manufacturers for the specific applications, temperatures and water conditions.
6. Also acceptable for 4 inch and larger galvanized steel, Schedule 40 piping above ground, is the use of a Victaulic grooved piping system including couplings, reducers, elbows, tees, and flange adaptors that are certified and approved by BOCA, IAPMO, SBCCI and UL for up to 300 psig working pressure and up to 230 degrees F operating temperature.
7. Also acceptable for 5-inch and larger is the use of copper piping, similar to the data listed for copper pipe 4-inch size and smaller.

E. Pipe and Fittings 3-inch and Larger (Underground)
1. Ductile Iron Pipe
a. Pipe: Conform to AWWA C151.
b. Cement-mortar lining: Conform to AWWA C104.
c. Protective coating outside: Bitumastic or coal tar enamel.
d. Thickness class: 53.
e. Pressure class: 350 psi
f. Joints: Mechanical or push-on, conform to AWWA C111.
g. Fittings
1) Gray iron or ductile iron
a) Full-body: Conform to AWWA C110, or
b) Compact: Conform to AWWA C153.
2) Class
a) 250 or 350 up to 24-inch diameter.
3) Bituminous coating: Inside and outside.
4) Cement lining: Conform to AWWA C104.
a) Polyethylene encasement.
5) Conform to AWWA C105.
6) Thickness: 8 mil.

2.2 PIPING AUXILIARIES/SPECIALTIES

A. General: All auxiliaries and specialties shall be guaranteed by the manufacturer for the pressure, temperature and materials being handled. All auxiliaries and specialties shall be suitable for the piping to which they are attached.

B. Interior Hose Bibbs

1. Manufacturers:
   a. HB-1 & HB-2: Woodford, Prier, Crane, Nibco, or Red-White.
   b. HB-3: Nibco, Harvel, Spears.
2. HB-1: Woodford Model 24-P with 3/4-inch brass construction, wheel handle, teflon impregnated packing, threaded inlet (concealed supply).
3. HB-2: Woodford Model 24C with 3/4-inch brass construction, wheel handle, teflon impregnated packing, soldered inlet (exposed supply).
4. HB-3: Nibco 3/4-inch true union CPVC ball valve with male adaptor on outlet suitable for 3/4-inch hose connection.

C. Wall Hydrants
1. Manufacturers: Josam, J.R. Smith, Mifab, Wade, Woodford, or Zurn.
2. WH-1: Josam 71000 freezeproof faucet, bronze casing, hinged, locking polished bronze (nickel) box and cover, self-draining vacuum breaker, integral backflow preventer, 3/4-inch size. Length as required.
3. WH-2: Josam 71050 freezeproof faucet, bronze casing, (polished brass), nickel head with polished face, self-draining vacuum breaker, integral backflow preventer, 3/4-inch size. Length as required.

D. Hose Valves
1. Manufacturers:
   a. HV-1: Potter Roemer 4110 w/4615 Chain & Cap; Elkhart: Crocker Standard; or equal.
   b. HV-2: Nibco, Harvel, or Spears.
2. HV-1: 1-1/2-inch forged brass globe valve with red wheelhandle, femal N.P.T. inlet, and suitable for standard 1-1/2-inch hose thread connection on outlet. 1-1/2-inch cast brass cap with female hose thread, pin lugs, and chain.
3. HV-2: Nibco Chemetrol 1-1/2-inch true union CPVC ball valve with male adaptor on outlet suitable for 1-1/2-inch male hose connection.

E. Water Meter
1. Meter is purchased from the utility company and installed by the Plumbing Contractor.
2. Provide meter installation meeting utility company requirements.

F. Strainers
1. Manufacturers: Sarco, Anderson, Armstrong, Crane, or Watts.
2. Sarco type BT or BF-150, bronze body with stainless steel screen. Provide drain valve on strainer.

G. Washer Connection Boxes
1. Manufacturers: Guy Gray, Oatey, Water-Tite, or Acorn.
2. Guy Gray Co. Model No. FB-200 (bottom supply) or #FBB-200TS (top supply) with 1/2-inch combination MPT brass sweat connection, 1/2-inch hose end valves, 2-inch drain pipe and overflow guard.
3. Where boxes are installed in concrete block walls, Contractor shall provide a stainless steel or chrome-plated trim on box so that it is flush with wall. No concrete block shall be exposed within enclosure. All exposed screws to be vandalproof.

H. Water Hammer Arresters
1. Manufacturers: Josam, Mifab, Wade, J.R. Smith, Watts, or Zurn.
2. Josam type “Absorbatron”.
3. Meet the requirements of PDI Standard WH-201 for size and location.
4. Size of unit shall be clearly indicated on unit.

I. Vacuum Breakers and Dual Checks
   1. Manufacturers: Watts, Chicago Faucet, Febco, Wilkins, Conbraco, or Woodford.
   2. Hose Connections: ASSE 1011, Watts #8A, 3/4-inch hose thread. (#8AC in finished areas).
   3. Ice Machines: ASSE 1024, Watts Series 7 with two chrome nickel plated brass replaceable dual checks for 3/8 inch thru 1 inch size.
   4. Coffee Maker: ASSE 1022, Watts SD-3 with stainless steel body, dual checks, wye strainer and drain port for 1/4 inch through 3/8 inch size. Pipe drain port to drain and terminate with air gap.

J. Backflow Preventers
   1. Manufacturers: Watts, Conbraco, Febco, Wilkins, Ames, or Mifab, Beeco.
   2. Pipes 1-1/2 inch and Smaller: ASSE 1013, Watts LF009 Series, all bronze, lead free, reduced-pressure-type with two ball valves. Provide strainer upstream.
   3. Pipes 2 inch and Larger: ASSE 1013, Watts 957 Series, lead free, reduced-pressure-type with two check valves, pressure relief valve, and two ball (2 inch size) or gate valves. Provide strainer upstream.
   4. Backflow preventers shall be serviceable without removal from pipe line.
   5. Provide indirect drain with air gap fitting.

K. Trap Primer
   1. Manufacturers: Josam, J.R. Smith, Wade, Zurn, Watts, Mifab, or E&S.
   2. Mifab M-500 trap primer with M1-DU distribution unit as required.
   3. Provide 1/2 inch soft type K copper pipe from the trap primer distribution devices to the trap primer inlet of the floor drains.
   4. Trap primer shall require no greater than 3 psi to activate.

L. Trap Primer Manifold System
   1. Precision Plumbing Products “Prime-Time” electronic trap priming manifold with atmospheric vacuum breaker, solenoid valve, water hammer arrestor, 3/4 inch copier manifold with 1/2 inch compression fitting taps, and 24-hour timer all installed in a 16 ga. steel enclosure with prime-coated access door and screwdriver door latch.
   2. Provide 1/2 inch soft type “K” copper pipe from the trap primer distribution system to the trap primer inlet of the floor drains.
   3. Electrical Contractor to provide 120 volt, one-phase, power to unit.
   4. See noted data on Plans relating to locations of distribution systems and number of outlets required at each system.
   5. Manufacturer: Precision Plumbing Products, Mifab, or Zurn.

M. Trap Seal Protection Devices
   1. Subject to compliance with requirements, provide SureSeal Manufacturing; Inline Floor Drain Trap Sealer or approved equal.
   2. Standard: ASSE 1072-2007
   3. Body: ASB Plastic
   4. Diaphragm & Sealing Gasket: Neoprene Rubber
   5. Size: 2 inch (50 mm), 3 inch (75 mm), 4 inch (100 mm).
   6. Gravity Drain Outlet Connection: Compression fit sealing gasket 80 durometer.

N. Drain Valves: Powell 502-HS with cap and chain, or equal by Hammond, Keystone, or Watts.

O. Water Pressure Regulator: Cash Acme type E-55, or equal by Cla-Val, Conbraco, Mifab, Watts.

P. Gauge Cocks: Powell Fig. 757, or equal by Anvil, Waltec, Victaulic, White Rogers.

Q. Hot Water Balancing Valves.
1. Manufacturers: Sarco W-SS-6, Flow Design Model (FDI) Model UA, Griswold or Tour Anderson (TA) Combination Balancing/Shut-Off.
2. Manual throttling venturi with union, chrome-plated ball, teflon seats, blowout-proof stem, adjustable memory stop, dual pressure and temperature ports, threaded or soldered connections, brass body, 600 psig at 205 deg F, ±3 percent accuracy.

R. Relief Valves
1. ASME tested and certified.
2. Shall have capacity to handle 100% of service.
3. Shall be set at 10% above the working pressure of equipment or service to which it is connected, or as noted.
4. Shall be iron body with stainless steel trim, renewable discs and seat rings, slow-opening-type.
5. Discharge shall be piped to nearest floor drain and arranged for safe discharge.
6. Manufacturers: Consolidated, Farris, Leslie, Lonergan, Manning-Maxwell-Moore.

S. Temperature Regulators
1. ASME-coded.
2. Shall be pilot operated, of packless construction, for dead-end service.
3. Main valve shall be cast iron body, single-seated, with SECO metal seat, normally closed and guaranteed to shut tight.
4. Shall have an adjustable bi-metal thermostat, with a bronze or stainless steel bulb suitable for the application. Shall be complete with gages.
5. Shall be sized to meet the capacity and service indicated.
6. Shall be installed with strainer, shut-off valves.
7. Manufacturers: Spence Engineering Co., Fisher, A W Cash, McLear.

T. Temperature and Pressure Relief Valves
1. ASME-coded
2. All-bronze construction with seat-to-disc alignment that will not stick or freeze.
3. Shall start to open at 230 deg F and shall be fully open at 240 deg F.
4. Shall have snap action thermostat and sensing bulb sized to water heater Manufacturer's recommendations
5. Manufacturers: Watts, McDonnel, Wilkins, Conbraco.

U. Pressure-Reducing Valve Assembly
1. Provide a code-approved pressure-reducing valve in the building service line when inlet pressure to building system can, at any time, exceed 70 psig, (set at 65 psig delivery pressure or as noted on the Drawings).
2. Include at each pressure-reducing valve: strainer, shut-off valves on each side, a full-size bypass with globe valve, 6 inch diameter pressure gages, with shut-off cocks on the serve and house sides, with union/flanged connections.
3. Properly support assembly independent of the piping.
4. Provide two parallel piped valves equal to Watts No. 115-7/N35B-FC-P-G-PG water pressure reducing valve with strainer, gauges and position indicator, as recommended by the manufacturer, as follows:

Service Line Size	Parallel Piped Valve Sizes
1-1/4 inch	Two at 3/4 inch
1-1/2 inch	Two at 1 inch
2 inch	Two at 1-1/4 inch

Service Line Size	Parallel Piped Valve Sizes
2-1/2 inch	Two at 1-1/4 inch
3 inch	Two at 1-1/2 inch
4 inch	Two at 2 inch
5 inch	Two at 2-1/2 inch
6 inch	Two at 3 inch

5. Pressure-reducing valve shall be an automatic control valve type, fluid-actuated and shall have a single moving assembly. Valve shall have a nylon fabric-reinforced synthetic elastomer diaphragm. Valve internal trim shall be stainless steel. An FDA-approved epoxy coating shall be heat-fusion-bonded to all internal and external ferrous valve surfaces. Valves shall be capable of automatically reducing inlet pressure to an adjustable maximum outlet pressure, regardless of fluctuation in demand.
6. Other acceptable manufacturers are Cla-Val, Sparco, or ITT.

V. Automatic Control Valves
1. 2 inch to 24 inch: Flanged cast iron body, Class 125 rated at 175 psig, pressure reducing balanced control valve with V-port throttling, stainless steel seat, stainless steel tubing and control filter.
   a. Bermad Model 724-V-T-U-F
2. Provide strainer and shut-off valve upstream of automatic control valve.
3. Manufacturers: Bermad, Cla-Val, Danfoss, Flowmatic, OCV, Watts.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General
1. Comply with Division 22 Section “Common Work Results for Plumbing”, as well as the requirements of Division 22 Sections “Hangers and Supports for Plumbing Piping, and “Plumbing Insulation”.
2. Piping shall be installed in a manner which permits easy removal of valves and disconnection of equipment. Unions or flanged joints shall be installed for this purpose.
3. Piping shall be installed, supported, guided, and anchored to properly provide for movement due to expansion and contraction without undue strains on the joints and in such a manner that it will not sag, buckle or sway.
4. Piping shall not be supported from other pipes, conduits, ducts or similar installations.
5. No piping shall be supported by the equipment to which it is connected. Install base elbows, hangers or other approved independent method of support for the pipe.
6. Connections to equipment shall be arranged to facilitate ease of removal and service without dismantling of the run-outs of main piping, and shall be installed by the use of multiple elbows or other similar methods to minimize strain on the equipment connections.
7. No field-fabricated welding fittings shall be permitted. All welding tees, elbows, reducers, and caps shall be commercially manufactured products.
8. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of the piping.
9. All open ends of pipes, including equipment connections, shall be properly sealed at all times during installation to keep dirt and all foreign material out of the piping. Plugs used shall be commercially manufactured products.

10. Pipe size reductions shall be made with factory-fabricated eccentric reducers or reducing fittings and shall be installed in a manner which does not cause pocketing or inhibit the flow of the material.
11. Install shut-off service valves with unions on all connections to equipment and on each side of control valves as required for ease of proper servicing and maintenance; see Division 22 Section “General Duty Valves for Plumbing Piping”.
12. Unless otherwise indicated, the discharge from pressure-and temperature-relief valves and equipment drains shall be piped to the nearest floor drain, hub drain, or mop sink, installed with an approved air gap as required, and arranged for safe discharge.
13. No pipe shall penetrate any structural member without the written approval of the A/E. Where such penetration is allowed, the structural member shall be reinforced subject to the approval of the A/E.
14. Flanges and Gaskets
    a. Where forged steel flanges are to be bolted to cast iron flanges, a smooth or flat-face forged steel flange with a full-face gasket shall be used.
    b. All gaskets, other than teflon envelope or full-face, shall be of the flat ring type, with the outside diameter of the gasket extending to the edge of the bolts.
    c. Gaskets for all joints shall have an inside diameter equal to the outside diameter of the pipes on which they are to be used, to ensure that no portion of the gasket will project into the ports of valves, pipe, or fittings.
    d. The dimensions of all gaskets shall conform to ANSI Standard B-16.21 for non-metallic gaskets.
15. Dielectric Separation
    a. Provide dielectric separation at all copper piping and valves connected to ferrous piping.
    b. Brass or bronze valves installed in ferrous piping shall not require dielectric separation.
    c. Connections between copper piping and ferrous flanged piping and equipment connections shall be with a bronze companion flange with dielectric separation for flanges and bolts.
    d. Connections between copper piping and screwed ferrous piping shall be Clearflow Dielectric Waterway fittings.
16. Movement
    a. Mains: Provide adequate offsets, bends, loops, flexible joints and guides as required to prevent over-stressing of piping and/or the structure.
    b. Branches: Provide for expansion and contraction by means of offsets, swings, joints or loops to eliminate stress on connected piping, valves or equipment. Provide for proper drainage as required.
    c. Maintain a free floating, properly braced and supported piping system.
17. Provide all rough-in and final connections to equipment and services indicated in the Contract Documents for equipment and services to be functional.

B. Cross Connections and Interconnections: No plumbing fixtures, devices, equipment or pipe connections shall be installed that will provide a cross-connection or interconnection between a potable water supply and any source of nonpotable water such as a drainage system, a soil or waste pipe, or a boiler or cooling tower where the water may be chemically treated.

C. Painting of Piping: Refer to Division 09 Section “Interior Painting”.

3.2 SLEEVES

A. General

1. All sleeves shall be accurately located as required under this Division, and shall be properly sealed. Sleeves shall be set true to line, grade and position, shall be plumb or level, and shall be maintained during the work under other Divisions.
2. Sufficient advance notice shall be supplied to the proper trade to enable the installation to progress.
3. Whenever improper location or insufficient notice is provided for the installation of the sleeves, such work shall be done by the proper trade at the cost of this Division, with no change in the Contract Sum or the Date of Substantial Completion.
4. Sleeves shall not penetrate any structural member, except as shown on Drawings, without written approval from the A/E. Wherever any additional reinforcing of members is required, the cost shall be under this Division.
5. Provide sleeves when underground piping passes under or through footings/grade beams. Sleeves under footings/grade beams shall have lean concrete from sleeve to underside of footing/grade beam.

3.3 BUILDING PIPING SYSTEM: INSTALLATION

A. Domestic Water: Cold, Hot, Tempered, Recirculating
   1. General
      a. All piping shall be installed and pitched to provide proper drainage.
      b. Install drain valves at all low points and as required to provide drainage facilities for the piping. Wherever system is sectionalized, install drain valves between each sectional shut-off valve.
      c. All hot water piping shall be pitched to provide natural gravity recirculation regardless of a recirculation pump.
      d. Install pressure gauge in domestic cold water main at water entrances to building.
   2. Shock Elimination
      a. All piping shall be protected against water shock.
      b. Install a water hammer arrestor of the proper size at the end of the main, at the end of all branch lines, and at the end of lines serving groups of fixtures.
      c. Water hammer arrestors shall be sized and installed as recommended by the Plumbing and Drainage Institute, and shall eliminate water hammer.
      d. All water hammer arrestors shall be installed in locations where they are readily accessible for service. Where required, provide suitable access doors.
   3. Contamination Protection
      a. All new distribution systems shall be protected against contamination due to backflow from non-potable sources.
      b. Provide an approved backflow preventer of the reduced pressure zone type at each connection to a fixture where indicated or required by code.
      c. Pipe to nearest floor drain.
   4. Backflow Prevention
      a. Install a code approved backflow preventer unit in the service main, where indicated on the Drawings, or as required by code.
      b. Include strainer, dual-service shut-off valves, double-check valves, and check cocks.
      c. Properly support, independent of the piping, with union connections.
   5. Trap Primer
      a. All trap primers are to be located in an accessible area, preferably in mechanical rooms, janitor's closets, or accessible chases.
      b. Install trap primer so that, for every 20 feet of piping to floor drain inlet, the device is mounted one foot above the finished floor.
   6. Water Meter
      a. Arrange for and pay all costs involved in the installation of a water meter in the building service line, where indicated.

b. Support independent of the piping with union connections.
c. Installation and meter shall be in accord with and approved by the water utility company.

END OF SECTION 221116

SECTION 221316 - BUILDING SANITARY AND STORM DRAINAGE

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Provide a complete building storm water drainage system to 5 feet outside building exterior wall. Work includes, but is not limited to, the following:
      a. Roof drains.
      b. Area drains.
      c. Trench drains.
      d. Pipe materials.
      e. Expansion joints.
      f. Clean-outs.
   2. Provide a complete soil, waste and vent piping system to 5 feet outside building exterior wall. Work includes, but is not limited to the following:
      a. Equipment coordination when equipment or fixtures are supplied by others.
      b. Pipe materials.
      c. Piping auxiliaries/specialties.
      d. Drains.
      e. Clean-outs.
   3. Lint Interceptor.

1.3 EQUIPMENT BY OTHERS

A. Include all necessary roughing-in and final equipment connections by the plumbing trade as specified.

B. Wherever equipment is furnished and set in place under Work of another Section or by Owner, they shall furnish detailed Drawings and exact rough-in dimensions and locations at the Site.
   1. Information shall be furnished sufficiently in advance to allow proper installation of all required services.
   2. This Division shall include all required service rough-ins and final connections to the equipment.

1.4 QUALITY ASSURANCE

A. General
   1. Provide all supervision, labor, tools, materials, equipment, accessories and specialties necessary to completely install, clean and test the building sanitary and storm plumbing systems.
   2. All materials shall be free from defects impairing strength and durability and shall be of the best quality for the purposes indicated. All Work shall have structural properties sufficient to solely sustain or withstand strain and stresses to which it is normally subjected and shall be true to detail.

B. Codes and Standards (Division 22 Section “Common Work Results for Plumbing” Listings and the following.)
1. Plumbing installation shall be in accordance with the state and local plumbing code and all other codes having jurisdiction.
2. American Standard Code for Pressure Piping ANSI B31.1.
3. National Association of Corrosion Engineers.
4. American National Standards Institute (ANSI).
5. American Society of Mechanical Engineers (ASME).
6. American Society for Testing and Materials (ASTM).
7. American Water Works Association.
8. Manufacturer's Standardization Society of the Valve and Fitting Industry.
9. Plumbing and Drainage Institute.
10. State or local Plumbing Code, as applicable.
11. State or local Building Code, as applicable.

C. Material Standards
1. ASTM A74-04: Specifications for Cast Iron Soil Pipe and Fittings.
2. ASTM A53-04: Specifications for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses.
3. ASTM B306-02: Specifications for DWV Copper Pipe.
4. ASTM C564-03: Specifications for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
5. Cast Iron Soil Pipe Institute CISPI No. 301-90 and ASTM A888-04: Specification Data for Hubless Cast Iron Pipe Systems with No-Hub Pipe and Fittings.
6. Cast Iron Soil Pipe Institute CISPI No. 310-90: Specification for coupling for use in connection with no-hub cast iron soil pipe and fittings for sanitary and storm drain, waste, and vent piping applications.
7. ASTM C1053-00: Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (OWV) Application.
8. ANSI A112.21.1-91: Floor Drains.
9. ANSI A112.36.2M-1991 (R2002): Metallic Clean-Outs.
10. ANSI A112.1.2-04: Air Gaps in Plumbing Systems.
11. ANSI A112.21.2M-1983: Roof Drains.

1.5 SUBMITTALS

A. Shop Drawings
1. Piping Systems: Submit piping layout drawings for sanitary waste and vent, and storm piping waste systems prior to installation.

B. Product Data: Catalog cuts.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Test reports.
2. Final approvals by authorities having jurisdiction.

1.6 HANDLING, DELIVERY, AND STORAGE

A. General
1. Handling, delivery, and storage shall be in accordance with the manufacturer's recommendations.

2. No extra cost shall be charged the Owner for handling, delivery, or storage.
3. In no case shall the pipe or appurtenance be dumped, dropped, or thrown.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. General
1. All pipe shall be cut off even and reamed full bore. Threads shall be cut smooth, true and to full standard size. Piping shall be installed clean of chips, burrs or oil.
2. No salvaged or used pipe shall be used without the written approval of the A/E or Owner. Wherever such approval is given, recut the ends of the pipe, square, cut new threads on screwed pipe, and thoroughly clean the pipe of all rust, dirt, scale and foreign matter before installation.
3. All cast iron pipe and fittings shall be marked with the trademark of the Cast Iron Soil Pipe Institute and listed by NSF International.

B. Buried Soil, Waste, and Vent Piping
1. ASTM A74 service weight cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasketed joints.
2. Options
a. ASTM A888 and CISPI 301 hubless cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with 304 corrugated stainless steel couplings.

C. Above-Ground Soil, Waste and Vent
1. ASTM A888 and CISPI 301 hubless cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with 304 corrugated stainless steel couplings.
2. Options
a. ASTM A74 service weight cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasketed joints.
b. ASTM A53 Schedule 40 galvanized steel pipe with cast iron screwed drainage fittings.
c. ASME A112.3.1 type 316L stainless steel drainage pipe and fittings, spigot, and socket joints with EDPM gaskets.

D. Indirect Waste and Drains Above Ground
1. ASTM B306 DWV copper tubing with DWV copper fittings.
2. Options
a. ASTM D2665 PVC-DWV plastic pipe, drainage fittings with solvent weld joints.
b. Same materials as soil, waste, and vent.

E. Sump Pump Discharges
1. ASTM A53 Schedule 40 galvanized steel with cast iron screwed drainage fittings shall be used to point of connection to a gravity storm line or terminating with air gap at plumbing fixture/equipment.
2. Options: ASTM B306 DWV copper tubing with DWV copper fittings.

F. Interior Buried Storm Piping
1. ASTM A74 cast iron service weight soil pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasketed.
2. Options

a. CISPI 301 hubless cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with 304 corrugated stainless steel couplings.
b. ASTM D1785 solid schedule 40 plastic pipe with ASTM D2665 drainage fittings and solvent welded joints.

G. Exterior Buried Storm Piping
1. ASTM A74 cast iron service weight soil pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasket or oakum-lead joints.
2. Options: ASTM D3034, Type PSM, polyvinyl chloride (PVC), SDR 35 for solvent cement or elastomeric joints. Fittings to conform to ASTM D2556.
a. Joints with elastomeric seals (integral bell) shall conform to ASTM D3212. Gaskets shall conform to ASTM F477.
b. Joints with solvent cement shall conform to requirements of ASTM D2885 and ASTM D2564.

H. Above Ground Storm Piping
1. CISPI 301 hubless cast iron pipe, as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with heavy duty 304 corrugated stainless steel couplings.
2. Options
a. ASTM A74 service weight cast iron pipe, bitumastic-coated, bell and spigot joints, drainage fittings with ASTM C564 gasketed.
b. ASTM A53 Schedule 40 galvanized steel pipe with cast iron screwed drainage fittings.
c. ASTM A112.3.1 type 316L stainless steel drainage pipe and fittings, spigot and socket joints with EDPM gaskets.

2.2 PIPING AUXILIARIES/SPECIALTIES

A. General: All auxiliaries and specialties shall be guaranteed by the manufacturer for the pressure, temperature and materials being handled, and shall be suitable for the piping to which they are attached.

B. Air Gap Fitting
1. J.R. Smith Fig 3951, rough bronze or plain end with set screw, threaded inlet and threaded outlet, sizes as indicated.
2. Manufacturers: Mifab, Watts, Wade, or Zurn.

C. Vent Flashings
1. Furnish 6 lb. lead flashing for General Contractor installation.
2. Flashing shall extend 12 inches in all directions, sealed between roofing plies, extended up to end of vent and clamped with vandalproof vent cap.
3. Vents Thru Roof (VTR): Refer to Architectural Drawings for vent thru roof detail in EPDM roof.

D. Vandalproof Vent Cap
1. J.R. Smith Fig. 1748 cast iron with set screws.
2. Manufacturers: Josam, Mifab, Stoneman, Wade, or Zurn.

E. Storm and Sanitary Piping Hubless Cast Iron Couplings
1. Shield constructed of type 304 stainless steel meeting ASTM 240. Neoprene gaskets shall conform to ASTM C564.

2. Couplings shall have a minimum of 4 bands and be capable of tightening to 80 lbs. torque.
3. The use of sealant or adhesives on couplings is not permitted unless approved by the manufacturer.
4. Couplings shall be heavy duty in accordance with ASTM C1540.

F. Cast Iron No-hub Restraints
1. Cast iron no-hub horizontal pipe and fittings, larger than 4", shall be suitably braced to prevent horizontal movement. Install at every branch opening or change in direction by the use of braces, blocks and rods to prevent movement or joint separation. This bracing may be field fabricated or a manufactured system.
2. Holdrite 117 series or equal.

2.3 DRAINS

A. General
1. All drains installed in waterproofed slabs shall be provided with a flashing ring.
2. Install a 30-inch x 30-inch x 6 lb. lead flashing properly fastened to the flashing ring.
3. Cast Iron roof, area, and floor drain manufacturers: J.R. Smith, Josam, Kusel, Mifab, Wade, Watts and Zurn.
4. Corrosion resistant floor drain manufacture: Zurn, Enfield, Kusel, Orion, R&G Sloan, and Duriron.

B. Roof Drains
1. RD-1: J.R. Smith Model 1015Y-RC. Large, general purpose roof drain with cast iron body, cast iron dome, bottom outlet, adjustable extension sleeve, reversed collar, flashing clamp with gravel stop, sump receiver, and underdeck clamp. Vandal-resistant top. Provide J.R. Smith Model 1710Y expansion joint on all bottom outlet roof drains. Size of piping on plan indicates outlet size of roof drains.
2. SRD-1: J.R. Smith Model 1080Y-RC. Flooding dam-type with 2-inch cast iron water collar, cast iron body, cast iron dome, bottom outlet, extension, flashing clamp with gravel stop, sump receiver, underdeck clamp. Vandal resistant top. Provide J.R. Smith 1710Y expansion joint on all bottom outlet roof drains. Size of piping on plan indicates outlet size of roof drain.
3. DSN-1: J.R. Smith Model 1770. Downspout nozzle, polished bronze body, NPT threads, wall flange with mounting holes. Size of piping on Plans indicates outlet size.

C. Floor Drains
1. Refer to drain schedule on drains.

2.4 CLEANOUTS

A. General
1. Capable of adjustment to match finish surface.
   a. Be round.
2. All cover plates/plugs shall be permanently labeled to match the drain service.
3. For cast iron fittings
4. Cast Iron clean-out manufacturers: Josam, J.R. Smith, Mifab, Wade, Zurn, Watts
5. Corrosion-Resistant Clean-Out Manufacturer: Duriron.

B. Clean-Out Types
1. Floor Clean-Outs
   a. Finished Floor and Tile Floor: J. R. Smith Fig. 4020, Duco cast iron body and frame with round adjustable scoriated nickel bronze top. Vandalproof top. Top

Labeled Co. Provide nickel bronze carpet clamping frame with vandalproof screw in carpeted areas.

b. Unfinished Floor and Equipment Area Floor: J. R. Smith Fig. 4240, Duco cast iron body and frame with round adjustable scoriated cast iron top. Vandalproof top. Top Labeled Co.

c. Corrosion resistant: Provide Duriron clean-out plug with floor access housing.

1) Finished Floor and Tile Floor: Zurn ZN-1404-VP floor access housing. ABS body with round nickel bronze top. Vandalproof top. Top Labeled Co.

2) Unfinished Floor: Zurn Z-1404-VP floor access housing. ABS body with round Dura-coated cast iron top. Vandalproof top. Top Labeled Co.

2. Wall Cleanouts

a. J. R. Smith Fig. 4422, Duco cast iron caulk ferrule with vast bronze taper thread plug and prime-coated steel shallow cover. Vandalproof screws.

b. Corrosion resistant: Provide Duriron plug. Provide with J.R. Smith Fig. 4720 wall access cover with frame, chrome-plated bronze. Vandalproof screws.

2.5 LINT INTERCEPTOR

A. Zurn Model Z1185, acid resistant interior and exterior fabricated steel interceptor. Non-skid secured cover with removable lift handle, aluminum lint intercepting secondary screen assembly, and permanent primary straining baffle with 3/8" [10 mm] diameter perforated holes

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General

1. Comply with Division 22 Section “Common Work Results for Plumbing”.
2. Piping shall be installed in a manner to permit easy removal of valves and disconnection of equipment. Unions or flanged joints shall be installed for this purpose.
3. Piping shall be installed, supported, guided, and anchored to properly provide for movement due to expansion and contraction without undue strains on the joints and in such a manner that it will not sag, buckle or sway.
4. Piping shall not be supported from other pipes, conduits, ducts or similar installations.
5. No piping shall be supported by the equipment to which it is connected. Install base elbows, hangers or other approved independent method of support for the pipe.
6. Connections to equipment shall be arranged to facilitate ease of removal and service without dismantling of the run-outs of main piping, and shall be installed by the use of multiple elbows or other similar methods to minimize strain on the equipment connections.
7. No field-fabricated welding fittings shall be permitted. All welding tees, elbows, reducers, and caps shall be commercially manufactured products.
8. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of the piping.
9. All open ends of pipes, including equipment connections, shall be properly sealed at all times during installation to keep dirt and all foreign material out of the piping. Plugs used shall be commercially manufactured products.
10. Pipe size reductions shall be made with factory-fabricated eccentric reducers or reducing fittings and shall be installed not to cause pocketing or inhibit the flow of the material.
11. No pipe shall penetrate any structural member without the written approval of the A/E. Where such penetration is allowed, the structural member shall be reinforced subject to the approval of the A/E.
12. Provide all rough-in and final connections to equipment and services indicated in the Contract Documents for equipment and services to be functional.

B. Cross Connections and Interconnections: No plumbing fixtures, devices, equipment or pipe connections shall be installed that will provide a cross-connection or interconnection between a potable water supply and any source of nonpotable water such as a drainage system, a soil or waste pipe, or a boiler or cooling tower where the water may be chemically treated.

3.2 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

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

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

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

F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

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

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

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendices.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendices.

3.3 SLEEVES: INSTALLATION

A. General
1. All sleeves shall be accurately located as required under this Division. Sleeves shall be set true to line, grade and position, shall be plumb or level, and shall be maintained during the work under other Divisions.
2. Sufficient advance notice shall be supplied to the proper trade to enable the installation to progress.

3. Whenever improper location or insufficient notice is provided for the installation of the sleeves, such work shall be done by the proper trade at the cost of this Division, with no change in the Contract Sum or the Date of Substantial Completion.
4. Sleeves shall not penetrate any structural member, except as shown on Drawings, without written approval of the A/E. Wherever any additional reinforcing of members is required, the cost shall be under this Division.
5. Provide sleeves when underground piping passes under or through footings/grade beams. Sleeves under footings/grade beams shall have lean concrete from sleeve to underside of footing/grade beams.

3.4 FLASHINGS: INSTALLATION

A. General
1. All penetrations of roofs and similar areas required for installation of vents, roof drains, and piping under this Division shall be properly flashed and made watertight.
2. Coordinate with all necessary General Trades Work sufficiently in advance and install in conjunction with roofing installation.

B. Flashing of Vent and Soil Pipe Extensions: All vent and soil pipe extensions through roof shall be minimum 3-inch size and flashed with 6 lb. sheet lead or 16 oz copper, 24-inch square, with sleeve soldered on, extending to top of pipe and turned down 2-inch inside.

C. Flashing of Roof Drains: All roof drains shall be flashed with 6 lb. sheet lead extending 12 inches from outer edge of drain opening.

D. Flashing of Curbs
1. Curbs shall be flashed under the General Trades Divisions of this Specification.
2. Provide counterflashing as required for weathertight construction.

3.5 BUILDING DRAINAGE SYSTEM: INSTALLATION

A. General
1. All storm and sanitary lines shall be of the sizes noted and routed as indicated.
2. Unless otherwise indicated or required by codes, all building drains shall be installed with a minimum uniform grade of one percent (1%).
3. No underground drains shall be installed in water. Trenches shall be dry and acceptable before laying of pipe.
4. All overhead lines shall be installed as close to the building structure as possible.
5. All overhead cast iron drains shall be supported at each joint, each change of directions, each cast iron trap, and all necessary intermediate points to maintain a uniform pitch without sagging or pocketing of the line.

B. Floor Drains
1. Install floor drains with lead flashing in waterproof floors per manufacturer's recommendations.
2. Install floor drains 1/2-inch lower than finished floor elevations to ensure positive drainage. Coordinate installation closely with General Contractor.

C. Cleanouts
1. Install at each of the following points, but not limited to:
   a. Base of each soil and waste stack
   b. Base of interior storm downspouts
   c. Change of direction of 45 deg or greater in the building drains
   d. Inside where the drains leave the building

e. Where a battery of wall hung water closets are installed, provide cleanout at end of sanitary line in wall.
f. Where indicated
g. Install on continuous runs of the drains at 100' intervals on the storm and sanitary.
h. As directed by local code

2. Shall be connected to the main with long sweep or sanitary wye fittings, unless otherwise noted.
3. Shall be installed to match the finished surface line.
4. Removable plugs shall be lubricated with a mixture of grease and graphite.

D. Traps
1. Install on all floor drains, all waste and soil discharge connections, and where indicated. Locate for ease of service. Any other traps required by official bodies having jurisdiction shall be installed at no additional cost to the Owner.
2. Where traps on plumbing fixtures are installed below grade or otherwise concealed, a clean-out shall be installed in the adjacent finished surface as indicated.

3.6 FIELD QUALITY CONTROL

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

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

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

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

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

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping**[, except outside leaders,]** on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

Prepare reports for tests and required corrective action.

END OF SECTION 221313

SECTION 22 33 00

DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Electric water heater.
   2. Recirculation pumps.
   3. Thermostatic mixing valves.
   4. Expansion tanks.
   5. Accessories.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
   1. Product data, including rated capacities of selected models, weights (shipping, installed and operating), furnished specialties, accessories, dimensions, required clearances, methods of assembly of components, piping and wiring connections.
   2. Wiring diagrams from manufacturers, detailing electrical requirements for electric power supply wiring to water heaters. Include ladder-type diagrams for interlock and control wiring required for final installations of water heaters and controls. Differentiate between portions of wiring that are factory-installed and portions that are to be field-installed.

1.4 QUALITY ASSURANCE

A. UL Standards: Provide water heater complying with the following:
   1. UL 1453, Electric Booster and Commercial Storage Tank Water Heaters.

B. Electrical Component Standard: Provide components complying with NFPA 70, National Electric Code.

C. Listing and Labeling: Provide water heaters that are listed and labeled.
   1. The terms "listed" and "labeled" shall be as defined in the National Electric Code, Article 100.
   2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

D. ASHRAE Standards: Provide water heaters with performance efficiencies not less than prescribed in ASHRAE 90A, Energy Conservation in New Building Design.

1.5 WARRANTY

A. Special Project Warranty
   1. Submit a written warranty, executed by manufacturer, agreeing to repair or replace water heater units that fail in materials or workmanship within the specified warranty period. Failures include, but shall not be limited to, tanks. This warranty shall be in addition to, and a limitation of, rights the Owner may have against the Contractor under the Contract Documents.
   2. Warranty period is 3 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRIC-TANK-TYPE WATER HEATER

A. Insulation: Fiberglass or polyurethane foam, surrounding tank.

B. Jacket: Steel, with baked-on enamel finish.

C. Tank: Glass-lined steel with anode rods and drain valve. Rated for 150 psi working pressure.

D. Heating Elements: Screw-in or flange bolt-in immersion-type, in multiples of 3 elements.

E. Controls: Adjustable immersion thermostat.

F. Safety Controls: Automatic, high-temperature-limit cut-off and low water cut-off.

G. Temperature and Pressure Relief Valve: ASME-rated and labeled.

H. The porcelainized glass-lined tank shall be protected:
   1. Against failure due to overheating caused by build-up of scale, film or other sediments by a cold water inlet tube, which is an integral part of the heater, that churns and agitates particles of sand, silt or scale present in water, so they are carried out of the water heater on successive hot water draws.
   2. Against electrolytic corrosion by magnesium anode rods.

I. Water heater tank(s) shall be covered by a 3-year limited warranty against failure due to metal fatigue or overheating caused by buildup of sand, sediment or sludge.

J. Heater to be set to maintain 140 degrees in the storage tank.

K. Manufacturers: A.O. Smith, State, Ruud, Lochinvar

2.2 RECIRCULATING PUMPS

A. In-line all lead-free bronze pump with gauge ports at nozzles and with vent and drain ports. Ceramic or carbon steel shaft supported by permanently lubricated carbon or steel bearings. Pump suitable for continuous operation at 230 deg F at 150 psi working pressure. Built-in

overload protection. Motor shall be non-overloading at any point on the pump curve. Capacity and electrical characteristics as noted on the Drawings.

B. Manufacturers: Bell & Gossett, Grundfos, TACO, Armstrong.

2.3 THERMOSTATIC MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Armstrong International, Inc.
   b. Lawler Manufacturing Company, Inc.
   c. Leonard Valve Company.
   d. Powers; a division of Watts Water Technologies, Inc.
   e. Symmons Industries, Inc.
   f. Bradley Corp.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components. Lead-free design.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, wall mounting bracket, and adjustable temperature-control. Thermometer on outlet.
8. Tempered-Water Setting: As noted on Drawings.
9. Valve Finish: Rough bronze.
10. Refer to Drawings for design characteristics such as flow rate and pressure drop.

2.4 EXPANSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
1. Available Manufacturers
   a. AMTROL Inc.
   b. Armstrong Pumps, Inc.
   c. Elbi of America, Inc.
   d. Taco, Inc.
   e. Watts Regulator Co.
   f. Wessels Co.
2. Construction
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread. Include tap for pressure gauge.
   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.
   d. ASME rated.
3. Capacity and Characteristics
   a. Working-Pressure Rating: 150 psig.
   b. Capacity Acceptable: Refer to Schedule on Drawings.
   c. Air Precharge Pressure: Set air pressure equal to incoming water pressure downstream of water service backflow preventer.

2.5 WATER HEATER ACCESSORIES

A. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) WITH ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

C. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

D. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.

E. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Construct concrete equipment base.

B. Install reinforcing bars, tied to frame and place anchor bolts and sleeves using manufacturer's installation template.

C. Place concrete and allow to cure before installation of equipment.

3.2 WATER HEATER INSTALLATION

A. General: Install water heaters on 4-inch concrete bases. Set and connect units in accordance with manufacturer's written installations instructions. Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances. Orient so controls and devices needing servicing are accessible.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections of Division 22. The drawings indicate general arrangement of piping, fittings and specialties. The following are specific connection requirements:
   1. Install piping adjacent to equipment arranged to allow servicing and maintenance.
   2. Connect hot and cold water piping to units with shut-off valves and unions. Extend relief valve discharge full-size to closest floor drain.
      a. Where water heater piping connections are dissimilar metals, make connections with dielectric fittings or dielectric unions specified in Division 22 Section “Common Work Results for Plumbing”.
      b. Install expansion tanks at cold water inlet piping as shown on drawings.
   3. Install drain as indirect waste spill into open drain or over floor drain.

a. Install drain valves at low point in water piping, for water heaters not having tank drain.

B. Electric Connections
1. Power wiring and disconnect switches area specified in Division 26.
2. Grounding: Connect unit components to ground in accordance with the National Electric Code.

3.4 FIELD QUALITY CONTROL

A. General
1. Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate and train Owner's maintenance personnel as specified below.
2. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing and preventative maintenance.
1. Review data in Operating and Maintenance Manuals. Refer to Division 01 Section “Contract Close-Out”.
2. Schedule training with at least 7 days’ advance notice.

3.5 COMMISSIONING

A. Perform the following before start-up final checks:
1. Fill water heater with water.
2. Piping system test complete.
3. Check for pipe connection leaks.
4. Test operation of safety controls and devices.

B. Perform the following start-up procedures:
1. Energize circuits.
2. Adjust operating controls.
3. Adjust hot water outlet temperature setting.

END OF SECTION 22 33 00

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Inclusion of all plumbing fixtures, complete and ready for use.
      a. All fixtures, except as otherwise specified, shall be constructed of vitreous china with all visible exposed surfaces glazed.
   2. Providing all stops, traps, escutcheons, connections, etc., as are necessary to complete the installation of each fixture, whether such items are listed or not.
   3. Plumbing Trim
      a. All finished exposed faucets, traps, connecting piping, stops, flush valves and other fixture trim shall be chromium-plated brass unless otherwise specified and shall be supported rigidly to fixtures and to walls with matching brackets at not more than 2'-0" center. All fastenings shall be chromium-plated brass or may be 302 stainless steel if of matching color and finish.
      b. Faucets shall be furnished as required. All faucets shall be lead-free.
      c. Vacuum breakers shall be provided as a part of the fixture trim wherever there is a possibility of back-siphoning.
   4. Fixture Stops
      a. Shut-offs for urinal and water closet flush valves shall be an integral part of the fixture or fitting; shut-offs for all other fixtures shall be loose-key, lock-shield-type.
      b. All fixture stops shall be angle- or straight-type adapted for each particular location and shall be located immediately adjacent to the fixture. Use threaded adaptors when used in conjunction with copper tube work. All stop valves shall be lead-free
   5. All exposed screws or fasteners for plumbing fixtures and faucets shall be vandalproof. Contractor shall take care to coordinate this item with his suppliers prior to Shop Drawings submittal.
   6. Aerators, where required for sinks and lavatories shall be vandalproof.

1.3 QUALITY ASSURANCE

A. Meet the requirements of the following:
   1. State Plumbing Code.
   2. State Department of Housing, Buildings and Construction.
   3. 42 USC 300G: The Reduction of Lead In Drinking Water Act.

B. Material Standards
   1. ANSI/ASME A112.19.2-2003: Vitreous China Plumbing Fixtures.
   2. ANSI/ASME A112.19.3-2000 (R2004): Stainless Steel Plumbing Fixtures (Designed for Residential Use).
   3. ANSI/ASME A112.19.4M-94: Porcelain Enameled Formed Steel Plumbing Fixtures.
   4. ANSI/ASME A112.19.5-1999: Trim for Water Closet Bowls, Tanks, and Urinals.
   5. ANSI/ASSE 1016-90: Performance Requirements for Thermostatic, Pressure Balancing and Combination Control Valves for Bathing Facilities.

6. ANSI/ASSE 1025-78: Performance Requirements for Diverters for Plumbing Faucets with Hose Spray, Anti-Siphon-Type, Residential Applications.

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Catalog cuts, including all fixture trim.

C. Samples: Not required for review.

D. Project Information: Not required for review.

E. Contract Close-Out Information
1. Operating and maintenance data.
2. Guarantees.

PART 2 - PRODUCTS

2.1 MATERIALS - GENERAL

A. Acceptable Manufacturers
1. Plumbing Faucets (Commercial Grade): Chicago Faucet, Delta, Moen, Powers, Symmons, Speakman, T&S Brass Co., Hydrotek
2. Flush Valves: Sloan, Delany, Zurn, and Hydrotek
3. Vitreous China Plumbing Fixtures: American Standard, Kohler, Eljer, Zurn.
4. Mop Sinks
   a. Terrazzo: Crane, Creative Industries, Fiat, Florestone, Stern and Williams.
   b. Molded Stone: Crane, Fiat, Florestone, Mustee, Swan Corp., Zurn.
5. Closet Seats: Church, Sperzel, Olsonite, Beneke, Centoco.
6. Shower Mixing Valves: Powers, Leonard, Lawler, Speakman, Bradley.
7. Stainless Steel Sinks: Elkay, Just, CECO, Metcraft.
8. Electric Water Coolers: Elkay, Haws, Oasis, Halsey-Taylor.
9. Precast Shower Receptacles: Fiat, Stern and Williams, Swan Corp.
10. Acrylic/Fiberglass Prefabricated Showers and Tubs: Aquatic, Aqua Glass, Aquarius, American Bath, Kohler.
11. Carriers: Josam, Mifab, Smith, Wade, Watts, Zurn.
12. Supply Stop Valves: Brasscraft, McGuire, Nibco, Watts.

B. Plumbing Fixtures – General: Constructed or equipped with anti-siphon devices to prevent siphoning waste material into potable water supply system.

C. Escutcheons and Plates: Conceal all holes where pipes pass through walls, floors or ceilings; use plates or escutcheons.

D. Piping Exposed in Finished Areas (including fittings and trim): Chromium-plated or nickel-plated brass with polished bright surface.

E. Trim for Lavatories and Sinks: Provide with renewable cartridges.

F. Vitreous Caps: Provide for water closet bolts.

G. Sealant: Silicone-type. See Division 7 Section “Joint Sealants”.

2.2 CHAIR CARRIERS

A. Carriers for Water Closets
   1. Use cast iron couplings where required by Code.
   2. Josam 12000 Series.

B. Carrier for Urinals: Josam 17800 or 17810.

C. Carriers for Lavatories: Josam 17100, 17100-76.

D. Carriers for Electric Water Coolers: Josam 17900 or 17905.

E. Carriers for Service Sinks: Josam 17720.

F. Carriers for Clinical Sinks: Josam 17730.

2.3 INSULATION AT HANDICAPPED (ADA-COMPLIANT) LAVATORIES

A. Insulation
   1. Handicapped lavatories exposed waste, hot and cold water supply lines shall be insulated with a molded, flexible vinyl insulation system with all fasteners. Provide insulation for 1-1/4-inch waste offset drain, tailpiece, P-trap and waste arm and 3/8-inch supply tubing and 3/8-inch keyed stop valve. Color shall be white.
   2. Manufacturers/Products
      a. IPS Corp Truebro Lav-Guard 2.
      b. Plumberex Pro-Extreme.
      c. McGuire ProWrap.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Sink manufacturer shall provide proper template to architectural woodwork supplier for cutting of countertop.

B. Plumber shall place sink in countertop and complete faucet and piping.

C. Install all fixtures in accordance with Manufacturer's recommendations.

D. All fixture support carriers shall be of the type necessary to permit adjustment to fit variations in construction. All grounds or special supports necessary for setting fixtures shall be provided before plastering or other finished construction work is begun. All fixtures shall be hung at standard height unless otherwise indicated by the A/E.

E. Minimum fixture connection sizes are shown on the Drawings.

F. Provide chrome-plated brass escutcheons on all waste and supply piping penetrating the walls and floors for fixtures, including piping within cabinets.

G. Provide fixture carriers and required drainage fittings on all wall hung fixtures. Anchor carriers securely to floor.

H. Where plumbing fixtures abut to walls, floors, and countertops, seal all joints with sealant.

I. Seal floor sinks to wall and floor with building sealant. Color shall match fixture.

J. Provide anchors behind the wall for flush valve supply piping.

K. Adjust self-sustaining closet seats for proper operation and to sustain in any position.

L. Adjust electric water coolers flow for correct operation and temperature.

M. Insulate the hot and cold water and waste piping under handicapped lavatories.

N. Adjust shower mixing valves for correct leaving water temperature.

O. After all fixtures have been set and are ready for use, and before the Contractor leaves the job, he/she shall thoroughly clean all fixtures furnished and set by him, removing all stickers, rust stains and any other matter or discoloration of fixtures, leaving every part in new condition. He/she shall, further, adjust all flush valves and other fixture water tempering or balancing at supplies to give proper water flow of fixtures.

END OF SECTION 224000

SECTION 230130.52 - EXISTING HVAC AIR DISTRIBUTION SYSTEM CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cleaning existing HVAC air-distribution equipment, ducts, plenums, and system components.

1.2 DEFINITIONS

A. ACAC: American Council for Accredited Certification.

B. AIHA-LAP: American Industrial Hygiene Association Lab Accreditation Program

C. ASCS: Air systems cleaning specialist.

D. CESB: Council of Engineering and Scientific Specialty Boards.

E. CMI: Certified Microbial Investigator.

F. CMC: Certified Microbial Consultant.

G. CMR: Certified Microbial Remediator.

H. CMRS: Certified Microbial Remediation Supervisor.

I. EMLAP: Environmental Microbiology Laboratory Accreditation Program.

J. IEP: Indoor Environmental Professional.

K. IICRC: Institute of Inspection, Cleaning, and Restoration Certification.

L. NADCA: National Air Duct Cleaners Association.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Cleaning agents
2. Antimicrobial surface treatments

1.4 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:

1. Project's existing conditions.

2. Evaluations and recommendations, including cleanliness verification.
3. Strategies and procedures plan.

1.5 CLOSEOUT SUBMITTALS

A. Post-Project report.

1.6 QUALITY ASSURANCE

A. ASCS Qualifications: A certified member of NADCA.

1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
2. Supervisor Qualifications: Certified as an ASCS by NADCA .

B. IEP Qualifications: CMI who is certified by ACAC and accredited by CESB.

C. CMR Qualifications: Certified by ACAC and accredited by CESB.

D. CMRS Qualifications: Certified by ACAC and accredited by CESB.

E. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

F. Cleaning Conference: Conduct conference at Project site.

1. Review methods and procedures related to HVAC air-distribution system cleaning, including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS

2.1 HVAC CLEANING AGENTS

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

1. Apex Engineering Products Corporation.
2. BBJ Environmental Solutions.
3. Goodway Technologies Corporation.
4. Nu-Calgon.
5. QuestVapco Corporation.

B. Description:

1. Formulated for each specific soiled coil condition that needs remedy.
2. Will not corrode or tarnish aluminum, copper, or other metals.

2.2 ANTIMICROBIAL SURFACE TREATMENT

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

1. Bio-Cide International, Inc.
2. Contec, Inc.
3. Ecolab, Inc.

B. Description: Specific product selected shall be as recommended by the IEP based on the specific antimicrobial needs of the specific Project conditions.

1. Formulated to kill and inhibit growth of microorganisms.
2. EPA-registered for use in HVAC systems and for the specific application in which it will be used.
3. Have no residual action after drying, with zero VOC off-gassing.
4. OSHA compliant.
5. Treatment shall dry clear to allow continued visual observation of the treated surface.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.

B. Perform "Project Evaluation and Recommendation" according to NADCA ACR.

C. Cleaning Plan: Prepare a written plan for air-distribution system cleaning that includes strategies and step-by-step procedures. At a minimum, include the following:

1. Supervisor contact information.
2. Work schedule, including location, times, and impact on occupied areas.
3. Methods and materials planned for each HVAC component type.
4. Required support from other trades.
5. Equipment and material storage requirements.
6. Exhaust equipment setup locations.

D. Existing Conditions Report: Prepare a written report that documents existing conditions of the systems and equipment. Include documentation of existing conditions, including inspection results, photo images, laboratory results, and interpretations of the laboratory results by an IEP.

1. Prepare written report listing conditions detrimental to performance of the Work.

E. Proceed with work only after conditions detrimental to performance of the Work have been corrected.

F. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.

G. Comply with NADCA ACR, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

H. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning.

3.2 CLEANING

A. Comply with NADCA ACR, including items identified as "recommended," "advised," and "suggested."

B. Perform electrical lockout and tagout according to Owner's standards or authorities having jurisdiction.

C. Remove non-adhered substances and deposits from within the HVAC system.

D. Complete cleaning in accordance with Owner-Contractor agreed-upon scope of work.

E. Systems and Components to Be Cleaned: All air-moving and -distribution equipment within the scope boundary.

F. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.

G. Particulate Collection:

1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,

H. Control odors and mist vapors during the cleaning and restoration process.

I. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.

J. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.

K. Clean all air-distribution devices, registers, grilles, and diffusers.

L. Clean non-adhered substance deposits according to NADCA ACR and the following:

1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
3. Clean evaporator coils, reheat coils, and other airstream components.

M. Air-Distribution Systems:

1. Create service openings in the HVAC system as necessary to accommodate cleaning.
2. Mechanically clean air-distribution systems specified to remove all visible contaminants, so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).

N. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.

O. Mechanical Cleaning Methodology:

1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

    a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
    b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials, such as duct and plenum liners.
2. Cleaning Mineral-Fiber Insulation Components:
    a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR.
    b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).
    c. Fibrous materials that become wet shall be discarded and replaced.

P. Coil Cleaning:

1. See NADCA ACR, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing coil cleaning verification.
2. Coil drain pans shall be subject to NADCA ACR, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
3. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
4. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations.
5. Rinse thoroughly with clean water to remove any latent residues.

Q. Application of Antimicrobial Treatment:

1. Apply antimicrobial agents and coatings if active fungal growth is determined by the IEP to be at Condition 2 or Condition 3 status according to IICRC S520, as analyzed by a laboratory accredited by AIHA-LAP with an EMLAP certificate, and with results interpreted by an IEP. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
2. Apply antimicrobial treatments and coatings after the system is rendered clean.
3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
4. Microbial remediation shall be performed by a qualified CMR and CMRS.

3.3 CLEANLINESS VERIFICATION

A. Verify cleanliness according to NADCA ACR, "Verification of HVAC System Cleanliness" Section.

B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.

C. Surface-Cleaning Verification: Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

D. Verification of Coil Cleaning:

1. Measure static-pressure differential across each coil.
2. Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of <Insert inches wg>, the differential measured when the coil was first installed.

E. Verification of Coil Cleaning: Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

F. Additional Verification:

1. Perform surface comparison testing or NADCA vacuum test.
2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.

G. Prepare a written cleanliness verification report. At a minimum, include the following:

1. Written documentation of the success of the cleaning.
2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
3. Surface comparison test results if required.
4. Gravimetric analysis (nonporous surfaces only).
5. System areas found to be damaged.

H. Photographic Documentation: Comply with requirements in Section 013233 "Photographic Documentation."

3.4 RESTORATION

A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR, "Restoration and Repair of Mechanical Systems" Section.

B. Restore service openings capable of future reopening. Comply with requirements in Section 233113 "Metal Ducts.

C. Reseal fibrous-glass ducts. Comply with requirements in Section 233116 "Nonmetal Ducts."

D. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."

E. Replace damaged insulation according to Section 230713 "Duct Insulation."

F. Ensure that closures do not hinder or alter airflow.

G. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

H. Restore manual volume dampers and air-directional mechanical devices inside the system to their marked position on completion of cleaning.

I. Measure air flows through air-distribution system.

J. Measure static-pressure differential across each coil.

3.5 PROJECT CLOSEOUT

A. Post-Project Report:

1. Post-cleaning laboratory results if any.
2. Post-cleaning photo images.
3. Post-cleaning verification summary.

B. Drawings:

1. Deviations of existing system from Owner's record drawings.
2. Location of service openings.

END OF SECTION 230130.52

SECTION 23051 - COMMON REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Shop Drawings

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

1.2 RELATED DOCUMENTS

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

1.3 GENERAL DIRECTION

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

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

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

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

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

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

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

E. All ducts shall be run as straight as possible and symmetrical with architectural items. Ductwork fabricated before coordination with the other trades will be done at the contractor's risk.

F. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of Bidder/Proposer's own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation from the Owner.

G. Each Bidder/Proposer shall also be governed by any unit prices and Addenda insofar as they may affect part of their work or services.

1.4 GENERAL STANDARDS

A. Provide materials, installation methods, workmanship, testing, etc., in strict accordance with the latest edition of applicable standards and adopted codes, including (but not limited to) the following.
1. State Building Code and applicable local amendments.
2. Local Building Code (if applicable)
3. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
4. American Society of Test Materials (ASTM)
5. National Fire Protection Association (NFPA)
6. Underwriters Laboratories (UL)
7. National Sanitation Foundation (NSF)
8. Sheet Metal & Air Conditioning Contractors National Association (SMACNA)
9. American National Standards Institute (ANSI)
10. Building Code Seismic Relative Displacement Requirements

1.5 PERMITS AND REGULATIONS

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

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

1.6 DEFINITIONS

A. Contractor - Any Contractor whether bidding, proposing or working independently or under the supervision of a General Contractor, Prime Contractor, Construction Manager and who installs any type of Mechanical Work as specified in the Contract Documents or, the General Contractor.

B. Engineer - The Consulting Mechanical-Electrical Engineer either consulting to the Owner, Architect, or Other, etc. In this case: CMTA, Inc., Consulting Engineers.

C. Architect - The Architect of Record for the project.

D. Contract Documents - All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Contract with Owner, etc.

E. Bidder/Proposer - Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.

F. The Project - All of the work required under this Contract.

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

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

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

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

K. Indicated - Listed in the Specifications, shown on the Plans or Addenda thereto.

L. Typical or Typ.- Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.

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

1.7 REQUESTS FOR INFORMATION

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

1.8 AVAILABILITY OF ELECTRONIC DRAWINGS

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

B. “Drawing Release” form can be obtained from the CMTA project manager upon request.

1.9 QUALITY ASSURANCE

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

1.10 INTENT AND INTERPRETATION

A. It is the intention of the Contract Documents to call for a complete and operational system, including all components, accessories, finish work, etc as necessary for trouble free operation; tested and ready for operation. Anything that may be required, implied, or inferred by the Contract Documents shall be provided and included as part of the Bid.

B. All Contractors and Vendors providing a bid for this project shall review the Plans and Specifications and determine any modifications and/or adjustments necessary relative to the proposed equipment and materials with specific manufacturer’s installation requirements. Include in the bid any necessary installation methods, features, options, accessories, etc. necessary to install the proposed equipment and materials, regardless of whether used as basis of design or being offered as a substitution in accordance with the specific manufacturer’s installation requirements whether specifically detailed or not within the Plans and Specifications.

C. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

D. The Bidder/Proposer shall completely review the Contract Documents. Any interpretation as to design intent or scope shall be provided by the Engineer / Architect. Should an interpretation be required, the Bidder/Proposer shall request a clarification not less than ten (10) days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event of any conflict, discrepancy, or inconsistency develops; the interpretation of the Engineer shall be final.

E. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten (10) days prior to bid. In the absence of such written notice and by the act of submitting a bid, it shall be understood that the Contractor has included the cost of all required items in the bid, and that will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

1.11 CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.:

A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, taps, tap fees, extensions, etc. in connection with their work. They shall also file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments and/or the appropriate municipality or utility company having jurisdiction, whether indicated or specified or not. They shall also obtain all required certificates of inspection for their work and deliver same to the Engineer before request for acceptance and final payment for the work.

B. Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.

C. The Contractor shall include in their work, without extra cost, any labor, materials, services, apparatus and Plans in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

D. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, or municipalities and with the requirements of all governmental agencies having jurisdiction.

E. All materials and equipment so indicated and all equipment and materials for the electrical portion of the mechanical systems shall bear the approval label of, or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable.

F. All plumbing work is to be constructed and installed in accordance with applicable codes, Plans and Specifications which have been approved in their entirety and/or reflect any changes requested by the Authority Having Jurisdiction. Plumbing work shall not commence until such Plans are in the possession of the Plumbing Contractor.

G. All Heating, Ventilation and Air Conditioning work shall be accomplished in accordance with the Building Code and amendments thereto, the latest standards recognized by the American Society of Heating, Refrigerating and Air Conditioning and the National Fire Protection Association.

H. The Contractor shall furnish three (3) copies of all Final Inspection Certificates obtained to the Engineer when work is complete. Final payment for work will be contingent upon compliance with this requirement.

I. Where minimum code requirements are exceeded in the Design, the Design shall govern.

J. The Contractor shall ensure that their work is accomplished in accord with the OHSA Standards and that they conduct their work and the work of their personnel in accord with same.

K. All work relating to the handicapped shall be in accord with regulations currently enforced by the Authority Having Jurisdiction and the American Disabilities Act.

L. Discharge of any toxic, odorous or otherwise noxious materials into the atmosphere or any system shall be subject to regulations of the Environmental Protection Agency (EPA) and/or the air pollution control commission. If in doubt, contact the State Department for Environmental Protection.

M. Where conflict arises between any code and the Plans and/or Specifications, the code shall apply except in the instance where the Plans and Specifications exceed the requirements of the code.

Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten (10) days prior to bid date, otherwise the Contractor shall make the required changes at their own expense.

1.12 PLANS AND SPECIFICATIONS:

A. The Plans are diagrammatic only and indicate the general arrangement of the systems and are to be followed. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work. The Plans are not intended to show every item which may be necessary to complete the systems. All Bidder/Proposers shall anticipate that additional items may be required and submit their Bid accordingly.

B. The Plans and Specifications are intended to supplement each other. No Bidder/Proposer shall take advantage of conflict between them, or between parts of either. Should this condition exist, the Bidder/Proposer shall request a clarification not less than ten (10) days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be final.

C. The Plans and Specifications shall be considered to be cooperative and anything appearing in the Specifications which may not be indicated on the Plans or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. Contractor shall make all of their own measurements in the field and shall be responsible for correct fitting. The work shall be coordinated with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make adjustments in location of piping, ductwork, equipment, etc. where such adjustments are in the interest of improving the project.

F. Should conflict, overlap or duplication of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume to be relieved of the work which is specified under their branch until instructions in writing are received from the Engineer.

G. Unless dimensioned, the Plans only indicate approximate locations of equipment, piping, ductwork, etc. Dimensions given in figures on the Plans shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to insure no conflict with other work.

H. Each Bidder/Proposer shall review all Plans in the Contract Documents to ensure that the work they intend to provide does not create a conflict with or affect the work of others in any way. Where such effect does occur, it shall be the Bidder/Proposer's responsibility to satisfactorily eliminate any such conflict or effect prior to the submission of their proposal. Each Bidder/Proposer shall in particular ensure that there is adequate space to install their equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the Bidder/Proposer and shall be accomplished fully without expense to others and that they are reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to insure adequate spaces.

I. Where on the Plans a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout

the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

J. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

K. Where within the Contract Documents the word “typical” or “typ.” is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.

L. Each Contractor shall evaluate ceiling heights specified on Architectural Plans. Where the location of equipment or systems may interfere with ceiling heights or maintenance and access of equipment or systems, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Do not install equipment or systems in the affected area until the conflict is resolved. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work or cost incurred on the part of the Contractor or unduly delay the work.

1.13 COOPERATION AND COORDINATION WITH OTHER TRADES:

A. The Contractor shall give full cooperation to all other trades and shall furnish in writing with copies to the Engineer, any information necessary to permit the work of other trades to be installed satisfactorily and with the least possible interference or delay.

B. Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than ¼" = 1'-0", clearly indicating how their work is to be installed in relation to the work of other trades, or so as not to cause any interference with work of other trades. Make the necessary changes in the work to correct the condition without extra charge.

C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.14 COST BREAKDOWNS (SCHEDULE OF VALUES):

A. Within thirty (30) days after acceptance of the Contract, the Contractor shall furnish to the Engineer, one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made in a format approved by the Engineer. Payments will not be made until satisfactory cost breakdowns are submitted.

1.15 HAZARDOUS MATERIALS:

A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building or site.

B. Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of their work, ensure that their workers are aware of this potential and what they are to do in the event of suspicion. The Contractor shall also keep

uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

C. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

D. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise them immediately.

E. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

F. No asbestos or mercury containing materials shall be installed in this project.

1.16 INDEMNIFICATION:

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

1.17 TEMPORARY SERVICES:

A. The Contractor shall arrange any temporary water, electrical and other services which may be required to accomplish the work. Refer also to General and Special Conditions.

B. All temporary services shall be removed by Contractor prior to completion of work.

1.18 WARRANTY / GUARANTEE

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

1.19 SURVEY, MEASUREMENTS AND GRADE:

A. The Contractor shall lay out their work and be responsible for all necessary lines, levels, inverts, elevations and measurements. The Contractor must verify the figures shown on the Plans before laying out the work and will be held responsible for any error resulting from failure to do so.

B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancy between actual measurements and those indicated which prevents following good practice or the intent of the contract documents, the Contractor shall promptly notify the Engineer and shall not proceed with this work until the Contractor has received instructions from the Engineer on the disposition of the work.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

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

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

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

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

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

PART 3 - EXECUTION

3.1 GENERAL DIRECTION

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

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

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

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

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

3.2 SUPERVISION AND WORKMANSHIP

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

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

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

3.3 CHANGE OF WORK

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

B. All pricing shall be in alignment with industry standard labor rates and estimated hours (based on RSMeans data). Any additional material or equipment shall be passed through with the standard industry excepted mark-up. All labor hours, labor rates, material costs, and equipment costs are subject to further questioning and approval from the Engineer.

C. All work commencing prior to approval will be at the risk of the contractor.

3.4 ARCHITECTURAL COORDINATION ITEMS

A. Cutting and Patching:
1. Cut and drill all openings in roofs, walls, and floors required for the installation. Neatly patch all openings cut. Hold cutting and patching to a minimum by arranging with other contractors for all sleeves and openings before construction is started.

B. Fire Caulking:

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

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

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

C. Access Panels:

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

D. Piping Sleeves:

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

E. Piping Escutcheon plates:

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

F. Expansion Joints:

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

3.5 PROTECTION OF EQUIPMENT AND SURFACES

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

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

C. The Contractor shall be entirely responsible for all material and equipment they furnish in connection with their work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All piping, etc., shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged, stolen or vandalized while stored on site, either before or after installation, shall be repaired or replaced by the Contractor at their expense. All ductwork with open ends shall be covered with plastic during construction.

3.6 REQUIRED CLEARANCES FOR ELECTRICAL EQUIPMENT

A. The NEC has specific required clearances above, in front, and around electrical gear, panels etc. The Contractor shall not install any piping, ductwork, etc., in the required clearance. If any appurtenance is located in the NEC required clearance, it shall be relocated at no additional cost. Coordinate with the Electrical Contractor prior to any work.

3.7 EQUIPMENT SUPPORT

A. Each piece of equipment, apparatus, piping, or conduit suspended from the ceiling or mounted above the floor level shall be provided with suitable structural support, pipe stand, platform or carrier in accordance with the best recognized practice. Such supporting or mounting means shall be provided by the Contractor for all equipment and piping. Exercise extreme care that structural members of building are not overloaded by such equipment. Provide any required additional bracing, cross members, angles, support, etc. Do not support items from roof/floor deck or bridging.

3.8 DUCT AND PIPE MOUNTING HEIGHTS

A. All exposed or concealed ductwork, piping, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed piping and ductwork shall, insofar as possible, run perpendicular or parallel to the building structure. Refer to Plans for minimum heights of ducts and piping. Minimum height above ceilings shall be 6" clear including insulation, unless otherwise noted.

3.9 BROKEN LINES AND PROTECTION AGAINST FREEZING

A. No conduits, piping, etc. carrying water or any other fluid subject to freezing shall be installed in any part of the building where danger of freezing may exist without adequate protection being given by the Contractor whether or not insulation is specified or indicated on the particular piping. All damages resulting from broken and/or leaking lines shall be replaced or repaired at the Contractor's own expense. Do not install piping across or near openings to the outside whether or not they are carrying static or moving fluids. Insulation on piping does not necessarily ensure that freezing will not occur. If in doubt, contact the Engineer.

3.10 WEATHERPROOFING:

A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as specified and approved by the Architect and Engineer before work is performed. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings permanently watertight.

B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

3.11 FINAL CONNECTIONS TO EQUIPMENT:

A. The Contractor shall finally connect mechanical services (water, sanitary, gas, air, etc.), to any terminal equipment, appliances, kitchen equipment, etc., provided under this and/or other divisions of the work. Various equipment connections indicated are based upon “basis of design” equipment selections. Should alternate equipment be purchased by the General Contractor, then this Contractor shall make the necessary provisions in the Bid for any and all differences. Change Orders shall not be considered for any differences due to alternate equipment purchase. Such connections shall be made in strict accord with current codes, safety regulations and the equipment manufacturer’s recommendations. If in doubt, contact the Engineer prior to installation.

3.12 UTILITY VERIFICATION REQUIREMENTS

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

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

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

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

3.13 ACCESSIBILITY:

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and ceilings for the proper installation of their work. They shall cooperate with all others whose work is in the same space. Such spaces and clearances shall, however, be kept to the minimum size required.

B. The Contractor shall locate and install all equipment so that it may be serviced, and maintained as recommended by the manufacturer. Allow ready access and removal of the entire unit and/or parts such as valves, filters, fan belts, motors, prime shafts, controls, coils, etc.

C. Whether shown on the Plans or not, the Contractor shall provide in the Bid access panels for each concealed shut-off valve, motorized control damper, manual air damper or other device requiring service as shown on Engineer's Plans or as required. Locations of these panels shall be identified

in sufficient time to be installed in the normal course of work. Change orders for access panels will not be accepted.

3.14 SCAFFOLDING, RIGGING AND HOISTING:

A. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery onto the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OHSA Standards and Requirements. Remove same from premises when no longer required.

3.15 CONCRETE WORK

A. The Contractor shall be responsible for the provisions of all concrete work required for the installation of any of their systems or equipment. The Contractor may, at their option, arrange with the others to provide the work. This option, however, will not relieve the Contractor of their responsibilities relative to dimensions, quality of workmanship, locations, etc.

B. In the absence of other concrete Specifications, all concrete related to Mechanical work shall be 3500 psi minimum compression strength at 28 days curing, slump: 4” ± 1”, air entrainment 4.5% water to cement ratio 0.5 and shall conform to the standards of the American Concrete Institute Publication AC1-318. Heavy equipment shall not be installed on pads for at least seven (7) days after pour.

C. All concrete pads shall be complete with all pipe sleeves, anchor bolts, reinforcing steel, concrete, etc. as required. Pads larger than 18" in width shall be reinforced with ½" deformed round bars on 6" centers both ways. Bars shall be approximately 2" above the bottom of the pad. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms, all surfaces shall be rubbed to a smooth surface. Chamfer all vertical edges ¾” and tool horizontal edges with ¾” radius.

D. In general, unless otherwise noted, concrete pads for equipment shall be 4” thick, extend six (6) inches beyond the equipment's base dimensions. Where necessary, extend pads 30 inches beyond base or overall dimensions to allow walking and servicing space. Insert 6-inch steel dowel rods into new and existing floors to anchor pads.

E. Exterior concrete pads shall be 8” thick with four (4) inches minimum, above grade and four (4) inches below grade on a compacted four (4) inch dense grade rock base unless otherwise indicated or specified. Surfaces of all foundations and bases shall have a smooth finish with one-half (½) inch chamfer on exposed edges. Turn down edges 18” below grade.

3.16 RESTORATION OF NEW OR EXISTING LANDSCAPING, PAVING, SURFACES, ETC.

A. The Contractor shall at their expense restore to their original conditions all paving, curbing, surfaces, drainage ditches, structures, fences, landscaping, existing or new building surfaces and appurtenances, and any other items damaged or removed by their operations. Replacement and repairs shall be in accordance with good construction practice; by qualified tradesman, and shall match materials employed in the original construction of the item and shall be to the satisfaction of the Owner and/or Engineer.

3.17 DELIVERY, STORAGE, HANDLING, AND PROTECTION

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

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

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

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

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

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

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

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

3.18 LOW VOLTAGE CONTROL WIRING FOR MECHANICAL EQUIPMENT

A. 120VAC Temperature Control Circuits
   1. Electrical Contractor shall provide all 120 Volt power wiring as required for temperature control panels and transformers to low voltage. Electrical Contractor shall connect to existing spare at electrical panel board and provide proper circuit breaker per NEC and label panel board accordingly. Mechanical contractor and temperature controls contractor shall coordinate with the electrical contractor accordingly.
   2. All other required 120VAC raceway and wiring related work shall be provided by the Electrical Contractor.
   3. The Electrical Contractor shall coordinate with the General Contractor to ensure thermal envelope is maintained at these locations.

3.19 FIRE ALARM RELATED WORK FOR MECHANICAL SYSTEMS

A. The drawings and specifications for this project require specific fire alarm devices, connections, wiring and programming associated with this division of work.

B. The electrical contractor will be installing a new fire alarm system or making modifications to an existing fire alarm control panel. Coordinate all fire alarm connections and programming that will be required with the electrical contractor to fulfil this division of work. This coordination shall take place at the start of the project so that all devices may be shown on fire alarm shop drawings.

C. Fire alarm devices to satisfy the requirements of this division of work will be furnished by the electrical contractor, installed by the mechanical contractor, wired and programmed by the electrical contractor. Mechanical and electrical contractor shall perform and be present for all tests of the system.

D. All required mechanical shutdowns of equipment shall be coordinated with the electrical contractor and with submitted equipment and performed in a controlled and safe manner in the presence of smoke. This shall be done via hardwired contacts and not via Building Automation System.

1. Whether shown on the drawings or not, all air handling units over 2000 CFM that serve more than one space shall have duct smoke detectors located in the return duct of each unit in accordance with the current State Mechanical Code, and NFPA 90A. The duct smoke detector shall be equipped with an auxiliary relay that immediately cuts power to the fan motor and notifies the fire alarm panel. All related work shall be coordinated accordingly with the electrical contractor. The duct detectors shall be installed downstream of the air filters and ahead of any branch connections in air supply systems having a capacity greater than 2,000 cfm. Where the duct detector cannot be located ahead of branch connections, multiple duct detectors shall be used to satisfy the intent of the code. Return system smoke detectors are not required when the entire space served by the air distribution system is protected by a system of area smoke detectors

3.20 CLEANING:

A. The Contractor shall, at all times, keep the area of their work presentable to the public and clear from rubbish and debris caused by their operations; and at the completion of the work, they shall remove all rubbish, debris, all of their tools, equipment, temporary work and surplus materials from and about the premises, and shall leave the area clean and ready for use. If the Contractor does not attend to such cleaning upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the Contractor. The Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of their rubbish or debris.

B. After completion of all work and before final acceptance of the work, the Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of piping, equipment, fixtures and all other associated or adjacent fabrication.

C. Ductwork and piping shall be kept clean at all times. Ductwork stored on the job site shall be placed a minimum of 4” above the floor and shall be completely covered in plastic. Installed ductwork shall be protected with plastic. Do not install the ductwork or insulation (pipe or duct) if the building is not “dried-in”. If this is required, the entire lengths of duct shall be covered in plastic to protect. The Owner/Engineer shall periodically inspect that these procedures are followed. If deemed unacceptable, the Contractor shall be required to clean the duct system utilizing a NADCA certified Contractor.

3.21 TEMPORARY USE OF EQUIPMENT:

A. The permanent heating and cooling equipment, when installed, may be used for temporary services, with the consent of the Engineer. Should the permanent systems be used for this purpose the Contractors shall make all temporary connections required at their expense. They shall also make any replacement required due to damage wear and tear, etc., leaving the same in "as new" condition.

B. Permission to use the permanent equipment does not relieve the Contractors from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

C. Warranties shall begin at substantial completion regardless of temporary use of equipment or not.

D. A pre-start-up conference shall be held in accordance with EQUIPMENT/CONTROLS START-UP AND VERIFICATION in this section.

E. For Air Handling Units during all phases of construction
   1. At a minimum, four complete sets of filter media are required for each unit. In each unit, install two sets of filter media during construction (more shall be required if construction activities dictate more frequent changes). In each unit, install one set of filter media at substantial completion. Leave one set of filter media in boxes in appropriate mechanical room as a spare set for the Owner. All other filters shall be used by the Contractor during construction. Dispose of all construction filter media.
   2. On the outside of all return air openings install a minimum of two sets of fiberglass filter media, such as cheesecloth, to be utilized as pre-filters for the “construction” filters. Install first set upon start-up and then install second set when first set is dirty. Dispose of all dirty construction filters. Change filters as often as necessary to keep units from becoming dirty at no additional cost.
   3. At substantial completion of the project the entire unit shall be cleaned to present a like “new” unit for the Owner and all filters shall be replaced with new.

F. For Heat Pump Units during all phases of construction
   1. At a minimum, four complete sets of filter media are required for each unit. In each unit, install two sets of filter media during construction (more shall be required if construction activities dictate more frequent changes). In each unit, install one set of filter media at substantial completion. Leave one set of filter media in boxes in appropriate mechanical room as a spare set for the Owner. All other filters shall be used by the Contractor during construction. Dispose of all construction filter media.
   2. On the outside of all exhaust air openings install a minimum of two sets of fiberglass filter media, such as cheesecloth, to be utilized as pre-filters for the “construction” filters. Install first set upon start-up and then install second set when first set is dirty. Dispose of all dirty construction filters. Change filters as often as necessary to keep units from becoming dirty at no additional cost.
   3. At substantial completion of the project the entire unit shall be cleaned to present a like “new” unit for the Owner and all filters shall be replaced with new.

3.22 NOISE, VIBRATION OR OSCILLATION

A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer. In case of moving machinery, sound or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor at their expense.

B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports whether indicated or not suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc. by means of flexible connectors, vibration absorbers, or other approved means.

C. Unitary equipment, such as room units, exhaust fans, etc., shall be rigidly braced and mounted to wall, floor or ceiling as required and tightly gasketed and sealed to mounting surface to prevent air leakage and to obtain quiet operation. Flush and surface mounted equipment such as diffusers, grilles, etc., shall be gasketed and affixed tightly to their mounting surface.

D. The Contractor shall provide supports for all equipment they furnish. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. If strength of supporting structural members is questionable, contact Engineer.

3.23 EQUIPMENT/CONTROLS STARTUP & VERIFICATION

A. The Contractor and their Subcontractors shall include in the bid to provide equipment and controls startup and verification for ALL Mechanical Systems specified for this project.

B. A pre-start-up conference shall be held with the Architect, Engineer, Owner, General Contractor, Mechanical Contractor, Electrical Contractor, Controls Contractor, Test and Balance Contractor, and the Manufacturer's providing startup services. The purpose of this meeting will be discussing the goals, procedures, etc. for start-up.

C. Specific line-items shall be included on the schedule of values by each Trade for "equipment and controls startup". These line-item values shall be approved by the Engineer. The Engineer, Owner and the Engineer's Field Inspector(s) shall closely monitor progress and quality of the equipment and controls startup and may withhold pay requests as deemed appropriate until satisfactorily completed.

D. Specific startup/verification specifications are included throughout the Mechanical Specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians, not third-party contractors, and shall complete and submit start-up reports/checklists. The Contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner. Where factory start-up is not specified for a particular piece of equipment or system, the Contractor shall be responsible to perform start-up. All information shall be completed by the Contractor and submitted to the Owner/Engineer prior to acceptance of the equipment.

E. The Contractor shall be responsible for completion of System Verification Checklists/Manufacturer's Checklists. Factory startup is required for all HVAC equipment noted. Unless noted otherwise, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians and shall complete and submit start-up reports/checklists.

F. The manufacturer's recommended startup procedures and checklists will be acceptable for use in the project. Where "manufacturer" startup is not specified, then this Contractor shall perform startup services in strict accordance with manufacturer's instructions. All startup/verification process shall be thoroughly documented by the Contractor and shall include the time and date when performed.

G. The Contractor shall "zip-tie" a start-up report to each piece of equipment in a clear plastic cover. Once start-up completion is verified by the Engineer the Contractor shall remove all reports and consolidate them into close-out documentation. The Contractor shall be responsible for completion of System Verification Checklist (SVC) / Manufacturer's Checklists.

3.24 INSPECTION, APPROVALS AND TESTS:

A. Before requesting a final review of the installation from the Architect and/or Engineer, each Contractor shall thoroughly inspect their installations to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineer for unnecessary and undue work on their part.

B. The Contractor shall provide as a part of this Contract any required Agency inspection, licensed and qualified to provide such services. All costs incidental to the provisions of inspections shall be borne by the Contractor.

C. The Contractor shall advise each Inspecting Agency in writing, with an informational copy of the correspondence to the Architect and/or Engineer, when they anticipate commencing the work. Inspections shall be scheduled for rough-in as well as finished work. The rough-in inspections shall be divided into as many inspections as may be necessary to cover all rough-in without fail. Failure of the Inspecting Agency to inspect the work in a timely manner and submit the related reports may result in the Contractor having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

D. Approval by an Agency Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these Plans and Specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.

E. Before final acceptance, the Contractor shall furnish the original and three (3) copies of the certificates of final approval by the Agency Inspector to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

3.25 ABOVE-CEILING AND FINAL PUNCH LISTS:

A. The Contractor shall review each area and prepare and complete their own punch list for each of the subcontractors as required for the Project Schedule.

B. Seven (7) days' notice shall be given to the Engineer for review of above ceiling work that will be concealed by tile or other materials. Seven (7) days' notice shall be given to the Engineer for review of below ceiling work and final inspection.

C. When all work from the Contractor's punch list is complete at each of the major Project Stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing seven (7) days prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review. The Contractor's representative may be requested at the inspections.

D. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money order (due net 10 days from date of each additional visit) at a rate of $125.00 per hour plus travel expense for extra trips required to complete either of the above ceiling, below ceiling or final punch lists.

3.26 OPERATING INSTRUCTIONS

A. Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating the systems and equipment for a period of three (3) days of eight (8) hours each, or as otherwise specified. Refer to Section HVAC EQUIPMENT for additional requirements. During this period, instruct the Owner or their representatives fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least seven (7) days written notice to the Owner, Architect and Engineer in advance of this training period. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representatives that were present.

B. Each Contractor shall furnish three complete bound sets for approval to the Engineer instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft form, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions. Refer to Specification Section SHOP DRAWINGS for additional detail.

C. Each Contractor, in the above-mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

3.27 RECORD DRAWINGS:

A. The Contractor shall insure that any deviations from the Design are as they occur recorded in red, erasable pencil on record drawings kept at the jobsite. The Engineer shall review the record documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose and deliver to the Engineer upon completion of the work.

3.28 DEMONSTRATION / TRAINING

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

END OF SECTION 230501

SECTION 230505 - EXISTING CONDITIONS AND DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

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

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

C. The Mechanical Contractor shall confirm the working operation and condition of existing systems to remain. The Mechanical Contractor shall note any malfunctioning systems, system deficiencies or any other noteworthy system items prior to commencement of work. The Mechanical Contractor shall provide a written systems condition assessment report to the owner prior to commencement of work. The owner shall sign the assessment report acknowledging the condition of the existing systems. The Mechanical Contractor shall protect these existing systems and shall be responsible for these systems during demolition and construction. The Mechanical Contractor shall be responsible for turning these existing systems back over to the owner in the same operating condition as the contractor received it. The mechanical contractor shall be responsible for repairing or replacing any malfunctioning systems, components or deficient systems to the satisfaction of the owner that have not been noted on the written systems condition assessment report. The mechanical contractor shall be responsible for all existing system components and operation in the absence of an owner-signed systems condition assessment report.

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

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

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

G. Routing of all new ductwork and piping work in existing buildings shall be approved by Owner's representative prior to installation.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 EFFECT ON ADJACENT OCCUPIED AREAS

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

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

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

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

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

3.2 WORK IN EXISTING SPACES

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

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

C. New Ceilings: Where existing air outlets are to remain, and the architectural drawings indicate replacement of the ceilings, this contractor shall temporarily remove air outlets, clean and store

temporarily. This contractor shall support existing run outs to structure to facilitate replacement of ceiling. This contractor shall re-install existing air outlets at previous locations and extend run outs to air outlets after new ceiling is installed. Refer to architectural drawings for all required ceiling replacements. Coordinate with all trades prior to re-installation.

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

E. HVAC Units: Replace all air filters in all HVAC equipment serving renovated space prior to turning space over to owner.

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

3.3 GENERAL DEMOLITION

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

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

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

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

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

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

G. All refrigerant evacuations and reclaim shall be required for demolished or relocated equipment.

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

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

3.4 DISPOSITION OF REMOVED EQUIPMENT & MATERIALS

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

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

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

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

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

3.5 PRE-EXISTING CODE VIOLATIONS

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

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

3.6 INTERIM LIFE SAFETY WORK

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

3.7 INTERIM INDOOR AIR QUALITY (IAQ) WORK

A. All requirements of this IAQ subsection shall be implemented prior to commencement of any demolition/construction activities.

B. No airborne dust or particulate matter shall be permitted to enter any occupied spaces or any air intakes to existing systems.

C. Become familiar with all affected HVAC systems to ensure that positive pressure can be maintained, relative to construction areas, in all areas adjacent to construction areas. This shall include all possible operational sequences of all systems such, including operation of smoke control, fire dampers, etc.

D. All return air and exhaust air terminals within all demolition/construction spaces shall be covered and properly sealed until construction is complete.

E. All air filters shall be checked at the beginning and end of each work shift and shall be changed in-kind as required to permit free airflow at all times.

F. Provide temporary exhaust throughout all demolition/construction spaces to ensure proper negative pressure is maintained relative to adjacent areas, including allowances for normal construction traffic through all access doors. Ensure that no windows or doors are left open which could upset the desired negative pressure.

G. Designate a dedicated qualified person to be on site to monitor all IAQ requirements, including checking filters three to four times per shift, checking for any breeches (by any contractor) such as drilled/cut openings in walls/floors, open windows, etc. Ensure that openings through walls and floors (by any contractor) are made immediately prior to installation of work and properly/permanently sealed immediately thereafter.

END OF SECTION 230505

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. 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.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:
1. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor (PSC).

2. Split phase.

3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

5. Electronically Commutated Motors (ECM).

B. Multi-speed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230519 - METERS AND GAGES 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 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

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

a. Blue Ribbon Corp.
b. Flo Fab Inc.
c. Miljoco Corporation.
d. Palmer Wahl Instrumentation Group.
e. Tel-Tru Manufacturing Company.
f. Trerice, H. O. Co.
g. Weiss Instruments, Inc.
h. Weksler Glass Thermometer Corp.
i. Winters Instruments - U.S.

2. Standard: ASME B40.200.
3. Case: Cast aluminum, 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle, unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 TEST PLUGS

A. Description: Test-station fitting made for insertion in piping tee fitting.

B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

C. Thread Size: NPS 1/4, ASME B1.20.1 pipe thread.

D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.4 TEST-PLUG KITS

A. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

B. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids (except steam).

H. Install test plugs in piping tees.

I. Install connection fittings in accessible locations for attachment to portable indicators.

J. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic coil in air-handling units.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 230519

SECTION 23 05 29.00 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Metal pipe hangers and supports
2. Trapeze pipe hangers
3. Metal framing systems
4. Thermal-hanger shield inserts
5. Fastener systems
6. Equipment supports

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, “Guidelines to Terminology for Pipe Hangers and Supports”

1.4 PERFORMANCE REQUIREMENTS

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

B. Structural Performance: Hangers and supports for HVAC piping, and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:
1. Metal pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers including product data for components
   2. Metal framing systems including product data for components
   3. Equipment supports

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped for hangers in contact with galvanized piping.
   3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   4. Hanger Rods: Continuous-thread rod, nuts, and washer made of steel or stainless steel in moist area.

B. Copper Pipe Hangers:
   1. Nonmetallic Coatings: Plastic coating, jacket, or liner for hangers in contact with copper piping.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Anvil International, Inc.
   2. B-Line Systems, Inc. (a division of Cooper Industries)
   3. ERICO/Michigan Hanger Company
   4. PHD Manufacturing, Inc

2.2 TRAPEZE PIPE HANGERS

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

2.3 THERMAL-HANGER SHIELD INSERTS

A. Description: 100 psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ERICO International Corporation.
   2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
   3. Rilco Manufacturing Co., Inc.

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

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

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

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

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head
      c. MKT Fastening, LLC
      d. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hilti, Inc
      b. ITW Ramset/Red Head
      c. MKT Fastening, LLC
      d. Powers Fasteners

2.5 EQUIPMENT SUPPORTS

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

2.6 ROOF EQUIPMENT SUPPORTS

A. Equipment supports: Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints and integrally formed deck-mounting flange at perimeter.

B. Support Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Material: Zinc-coated galvanized steel sheet, 0.052 inch thick.

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

1. Curbs Plus, inc.
2. Pate Company (The)
3. Roof Products, Inc.
4. Thybar Corporation

2.7 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

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

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

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

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

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

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

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

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

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

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

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

M. Hangers: Provide adjustable, Steel Clevis Hangers (MSS Type 1) for suspension of noninsulated or insulated, stationary pipes.

N. Horizontal-Piping Clamps: Provide Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3) for suspension of pipes requiring clamp flexibility and up to 4 inches of insulation.

O. Vertical-Piping Clamps: Provide extension pipe or Riser Clamps (MSS Type 8) for support of pipe risers.

P. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

Q. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Inserts:
   a. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from structural concrete ceiling.
2. Clamps:
   a. C-Clamps (MSS Type 23): For structural shapes.
   b. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
3. Miscellaneous:
   a. Welded Beam Attachments (MSS Type 22): For attaching to bottom of steel beams if loads are considerable and rod sizes are large.
   b. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      1) Light (MSS Type 31): 750 lb.
      2) Medium (MSS Type 32): 1500 lb.
      3) Heavy (MSS Type 33): 3000 lb.
   c. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
   d. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

R. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

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

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

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

V. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

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

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

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

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

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

CC. Provide pipe rollers for hot water mains where piping is above 140 degrees. Provide pipe rollers approved equal to Anvil Fig. 171, 175, 177, 181 and 271.

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

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

FF. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation. Do not exceed pipe stresses allowed by manufacturer.
      b. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      c. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

d. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Shields:
   a. Install protective galvanized steel shields, MSS Type 40, on insulated piping smaller than 2-inch NPS. Shields shall span an arc of 180 degrees and shall be a minimum of 12-inches in length.
   b. Install thermal-hanger shield inserts on all insulated piping 2-inch NPS and larger.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

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

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

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

D. Concrete bases shall extend at least 4” beyond the bed or frame of the supported machine. Equipment bases shall have straight and finished sides and a 1”-45 degree chamfer at the top. Reinforcing steel bars (Type #4) shall be placed in a grid pattern in both directions of the base spaced at 12” on center.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports. Install and align fabricated anchors in indicated locations.

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

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

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.

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

3.6 HANGER AND SUPPORT SCHEDULE

A. Piping:

Piping Material	Pipe Size	Hanger Spacing (OC)
Steel	NPS 1-1/4” and smaller	8’-0”
Steel	NPS 1-1/2” to NPS 2”	10’-0”
Steel	NPS 2-1/2” and larger	12’-0”
Copper	1” and smaller	6’-0”
Copper	1-1/4” and larger	8’-0”

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

END OF SECTION 23 05 29.00

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Brady Corporation.
   b. Brimar Industries, Inc.
   c. Carlton Industries, LP.
   d. Champion America.
   e. Craftmark Pipe Markers.
   f. emedco.
   g. Kolbi Pipe Marker Co.
   h. LEM Products Inc.
   i. Marking Services, Inc.
   j. Seton Identification Products; a Brady Corporation company.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
3. Letter Color: White
4. Background Color: Black
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

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

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. emedco.
7. Kolbi Pipe Marker Co.
8. LEM Products Inc.
9. Marking Services, Inc.
10. Seton Identification Products; a Brady Corporation company.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: White

D. Background Color: Red

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

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

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Services Inc.
11. Seton Identification Products; a Brady Corporation company.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

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

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

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping and at least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 DUCT LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. emedco.
7. Kolbi Pipe Marker Co.
8. LEM Products Inc.
9. Marking Services Inc.
10. Seton Identification Products; a Brady Corporation company.

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

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

D. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: Size letters at least 1 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

E. Letter Color: White

F. Background Color: Varies by duct type. See schedules below.

G. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

2.5 VALVE TAGS

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

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Services Inc.
11. Seton Identification Products; a Brady Corporation company.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

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

2.6 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. emedco.
7. Kolbi Pipe Marker Co.
8. LEM Products Inc.
9. Marking Services Inc.
10. Seton Identification Products; a Brady Corporation company.

B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

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

B. Coordinate installation of identifying devices with locations of access panels and doors.

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

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

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

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

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:
   1. Heating Water Piping: White letters on a safety-green background
   2. Refrigerant Piping: White letters on a safety-purple background

3.5 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

   1. Blue for cold-air supply ducts.
   2. Yellow for hot-air supply ducts.
   3. Green for exhaust-, outside-, relief-, return-, and mixed-air ducts.

3.6 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units.

   1. Valve-Tag Colors:

      a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
      b. Flammable Fluids: Black letters on a safety-yellow background.
      c. Combustible Fluids: White letters on a safety-brown background.
      d. Potable and Other Water: White letters on a safety-green background.
      e. Compressed Air: White letters on a safety-blue background.
      f. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualification to perform TAB work.

F. TDH: Total dynamic head.

G. UFAD: Underfloor air distribution.

1.3 INFORMATIONAL SUBMITTALS

A. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

B. Certified TAB reports.

C. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.4 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC, NEBB, or TABB

1. TAB Field Supervisor: Employee of the TAB specialist and certified by one of the agencies above.
2. TAB Technician: Employee of the TAB specialist and certified by one of the agencies above.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

1. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

D. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.5 FIELD CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

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 TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in

AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, and verify that they are accessible and their controls are connected and functioning.

K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.

L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.

e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning in accordance with the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.3 PREPARATION AND COORDINATION REQUIREMENTS – GENERAL

A. Shop drawings, submittal data, up-to-date revisions, change orders, and other data required for planning, preparation, and execution of the TAB work shall be provided to the TAB Agency no later than 30 days prior to the start of TAB work.

B. System installation and equipment startup shall be complete prior to the TAB Agency’s being notified to begin.

C. The building control system shall be complete and operational. The Building Control system (sub)contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.

D. All test points, balancing devices, identification tags, etc. shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.

E. Qualified installation or startup personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.

3.4 PREPARATION AND COORDINATION REQUIREMENTS – HVAC CONTROLS

A. Written notice shall be submitted through the General Contractor to the Architect-Engineer stating that the Control System is operating and controlling the HVAC System.

B. The Contractor/Control (sub)contractor shall have entered all data needed for the TAB Agency to begin work.

C. The Contractor/Control (sub)contractor shall be available to correct any problems that the TAB Agency may encounter with the systems.

D. All costs for additional work by the TAB Agency due to the Contractor's failure to comply with the above shall be paid by the Contractor and any subcontractor(s) for HVAC controls.

3.5 PREPARATION AND COORDINATION REQUIREMENTS – MECHANICAL

A. Written notice shall be submitted through the General Contractor to the Architect stating that the HVAC system is operational and ready for the TAB Agency.

B. The Contractor/Mechanical subcontractor shall have proved all units operational and all air outlets in the full open position.

C. The Contractor/Mechanical subcontractor shall be available to correct any problems that the TAB Agency might have with any equipment or systems.

D. The Contractor/Mechanical subcontractor shall furnish and install any replacement sheaves, pulleys and drive belts required for flow adjustments, as determined by the TAB Agency. Adjustable sheaves shall be selected so that the final adjustment position is in the middle third of the total adjustment range.

E. All costs for additional work by the TAB Agency due to the Contractor's failure to comply with the above shall be paid by the Contractor and any subcontractor(s) for mechanical work.

3.6 PREPARATION AND COORDINATION REQUIREMENTS – DUCTWORK

A. Ductwork air leakage testing shall be performed by the TAB Agency.

B. The ductwork/sheetmetal subcontractor shall promptly correct any related problems discovered by the leakage tests.

C. All costs associated with retesting and/or delays or other problems which impede the TAB Agency from performing such testing shall be paid by the contractor and any subcontractor(s) for ductwork.

3.7 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems ", or ASHRAE 111 for LEED Projects.

B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.

3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

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

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

3.8 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings.

3.9 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' Record drawings duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

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

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

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

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

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

3.10 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.11 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
    c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

6. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Balance the return-air ducts and inlets.
    b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:

    a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
    b. Re-measure and confirm that total airflow is within design.
    c. Re-measure final fan operating data, speed, volts, amps, and static profile.
    d. Mark final settings.
    e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
    f. Verify tracking between supply and return fans.

3.12 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and equipment flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
5. Verify that motor controllers are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

1. Check settings and operation of each safety valve. Record settings.

3.13 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design flow.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gauge heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
    e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

D. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

G. Verify that memory stops have been set.

3.14 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the pressure-differential sensor(s) is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no flow diversity:

1. Adjust pumps to deliver total design flow.

a. Measure total water flow.

1) Position valves for full flow through coils.
2) Measure flow by main flow meter, if installed.
3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

b. Measure pump TDH as follows:

1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gauge heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.

a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.

e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:

   a. Measure differential pressure and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:

   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system pressure-differential set point(s).
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:

   a. Re-measure and confirm that total flow is within design.
   b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
   c. Mark final settings.

D. For systems with flow diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by Architect.
3. Adjust pumps to deliver total design flow.

   a. Measure total water flow.

      1) Position valves for full flow through coils.
      2) Measure flow by main flow meter, if installed.
      3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

   b. Measure pump TDH as follows:

      1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      3) Convert pressure to head and correct for differences in gauge heights.
      4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.

5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

6. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

3.15 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

3.16 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record entering and leaving refrigerant pressures.

D. Measure and record operating data of compressor(s), fan(s), and motors.

3.17 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each hydronic coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Air pressure drop.
5. Voltage and amperage input of each phase at full load.
6. Calculated kilowatt at full load.
7. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Entering and leaving refrigerant pressure and temperatures.

3.18 DUCT LEAKAGE TESTS

A. Witness the duct leakage testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.19 PIPE LEAKAGE TESTS

A. Witness the pipe pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.20 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify HVAC control system is operating within the design limitations.
2. Verify that controllers are calibrated and function as intended.
3. Verify that controller set points are as indicated.
4. Verify the operation of lockout or interlock systems.
5. Verify the operation of valve and damper actuators.
6. Verify that controlled devices are properly installed and connected to correct controller.
7. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
8. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.21 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).
2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.
3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
4. Check the refrigerant charge.
5. Check the condition of filters.
6. Check the condition of coils.
7. Check the operation of the drain pan and condensate-drain trap.
8. Check bearings and other lubricated parts for proper lubrication.
9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.22 TOLERANCES

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

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
2. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
3. Heating-Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.
4. Condenser-Water Flow Rate: Plus or minus 5 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.23 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

3.24 FINAL REPORT

A. Final TAB Report – The TAB Agency shall submit the final TAB report for review by the engineer. All equipment including but not limited to fans, outlets, traverses, static pressure profiles, pumps, coils, etc. shall be identified in the report. The report must also include, at minimum, electronic drawings that correspond to all test points for additional report clarification. The TAB Agency shall submit an “National Project Performance Guarantee” assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and National Standards.

B. Submit three (3) electronic copies of the Final TAB Report to the Architect-Engineer, and (1) electronic copy to the Project Manager from the Division of Engineering and Contract Administration. A maximum of three (3) additional hard copies shall be submitted on request.

C. Payments for the TAB work shall be contingent upon the proper submittal and approval of the TAB reports.

3.25 DEFICIENCIES

A. Any deficiencies in the installation or performance of a system or component observed by the TAB Agency shall be brought to the attention of the appropriate responsible person. Also notify the mechanical project representative from the Division of Engineering and Contract Administration.

B. The work necessary to correct items on the deficiency listing shall be performed and verified by the affected contractor before the TAB Agency returns to retest. Unresolved deficiencies shall be noted in the final report.

END OF SECTION 230593

SECTION 23 07 13.00 - DUCT INSULATION

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 insulating the following duct services:
   1. HVAC Ductwork.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, and accessories.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
   3. Detail application at linkages of control devices.

D. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, installed R-values and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ANSI/ASTM E 84 and NFPA 255, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

C. Installed R-Values for insulation on ducts shall comply with local mechanical and energy code as required for indoor applications.

D. Insulation tape shall comply with UL 181.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

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

1.8 SCHEDULING

A. Schedule insulation application after pressure testing duct systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 DUCTWORK INSULATION MATERIALS

A. Manufacturers
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corp.; SoftTouch Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Friendly Feel Duct Wrap.
      d. Owens Corning; SOFTR All-Service Duct Wrap.
      e. Thermaduct, LLC

B. Interior (indoor) ductwork insulation shall have a minimum installed thermal resistance value of R6 or code minimum, whichever higher.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, without facing and with vapor barrier Type II with factory-applied kraft paper, reinforcing scrim, aluminum foil and vinyl jackets.

E. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB. For duct and plenum applications, provide insulation without facing and with vapor barrier with factory-applied kraft paper, reinforcing scrim, aluminum foil and vinyl jacket.

F. Vapor Barrier Material for Ductwork: Paper-backed aluminum-foil, except as otherwise indicated; strength and permeability rating equivalent to factory-applied vapor barriers on adjoining ductwork insulation, where available; with following additional construction characteristics:
   1. High Puncture Resistance: Low vapor transmission (for ducts in exposed, high traffic areas susceptible to damage: Mech. Rooms, etc.)
   2. Moderate Puncture Resistance: Medium vapor transmission (for ducts in concealed areas).

G. Ductwork Insulation Accessories: Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

H. Ductwork Insulation Compounds: Cements, mastics, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

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

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

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

E. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed. Duct lining thermal resistance value shall comply with external duct wrap requirements.

F. Corner Angles: Install corner angles on external corners of insulation on ductwork in exposed finished spaces.

G. Provide insulation on collar and backside of supply diffusers in all ceiling spaces. Provide insulation on plenum box of all supply grilles and registers in all ceiling spaces.

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

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

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

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

L. Keep insulation materials dry during application and finishing.

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

N. Install insulation with least number of joints practical.

O. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

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

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

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

S. Do not overly compress insulation which will result in decreased thermal resistance properties. Install insulation as recommended by the insulation manufacturer.

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

3.4 DUCT INSULATION SCHEDULE, GENERAL

A. All ductwork shall be insulated except:
1. Double-Wall duct.
2. Fibrous-glass ducts.
3. Fabric ductwork.
4. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
5. Factory-insulated flexible ducts.
6. Factory-insulated plenums and casings.
7. Flexible connectors.
8. Vibration-control devices.
9. Factory-insulated access panels and doors.
10. Supply ductwork exposed in conditioned spaces excluding mechanical rooms, server rooms and electric equipment rooms.
11. Toilet exhaust, general exhaust and return ductwork in an insulated joist or attic space.

B. Grilles, Registers, and Diffusers:
1. Provide insulation on collar and backside of supply diffusers in all ceiling spaces. Provide insulation on plenum box of all supply grilles & registers in all ceiling spaces.

3.5 PENETRATIONS

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

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

C. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.

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

3.7 PROTECTION AND REPLACEMENT

A. Repair damaged vapor barrier using vapor barrier tape to fully cover torn area.

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

C. 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 07 13.00

SECTION 23 07 19.00 - HVAC PIPING INSULATION

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 insulating the following HVAC piping systems:
   1. Air Conditioning Condensate drain piping.
   2. Condenser-water piping.
   3. Heating hot-water piping.
   4. Refrigerant suction and hot-gas piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.

C. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ANSI/ASTM E 84 and NFPA 255, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

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

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

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

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Pittsburgh Corning Corporation; Foamglass.
   b. Caltherm Insulation.
   c. Johns Manville.
2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I without slits for tubular materials.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Armacell LLC; AP Armaflex.
   b. Aeroflex USA.
   c. K-Flex USA.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Owens Corning; SOFTR All-Service Duct Wrap.

I. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Micro-Lok.
   b. Knauf Insulation; 1000-Degree Pipe Insulation.
   c. Owens Corning; Fiberglas Pipe Insulation.

J. Vapor Barrier Material: Paper-backed aluminum foil, except as otherwise indicated, strength and permeability rating equivalent to adjoining pipe insulation jacketing

2.2 INSULATING CEMENTS

Mineral-fiber insulating cement is suitable for temperatures from 100 to 1600 deg F (38 to 871 deg C). Vermiculite insulating cement is suitable for temperatures from 100 to 1800 deg F (38 to 982 deg C).

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Ramco Insulation, Inc.; Thermokote V.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

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

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
   d. K-Flex USA; R-373 Contact Adhesive.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
   d. Mon-Eco Industries, Inc.; 22-25.

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
      b. Eagle Bridges - Marathon Industries; 501.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
      d. Mon-Eco Industries, Inc.; 55-10.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
   3. Service Temperature Range: 0 to 180 deg F.
   4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
   5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
      b. Eagle Bridges - Marathon Industries; 550.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
      d. Mon-Eco Industries, Inc.; 55-50.
      e. Vimasco Corporation; WC-1/WC-5.
   2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: 60 percent by volume and 66 percent by weight.
   5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
      b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
      c. Vimasco Corporation; 713 and 714.
   2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
   3. Service Temperature Range: 0 to plus 180 deg F.
   4. Color: White.

2.6 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
      d. Mon-Eco Industries, Inc.; 44-05.

e. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Approved equal
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
3. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
a. Products: Subject to compliance with requirements, provide one of the following:
1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
2) Approved equal
4. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; 20 mil thickness; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      b. P.I.C. Plastics, Inc.; FG Series.
      c. Proto Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
      b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
      c. RPR Products, Inc.; Insul-Mate.
   2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14,. Smooth finish, 0.016 inch thickness
      a. Factory cut and rolled to size.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
      d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
      e. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Valve covers.
      f. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film.
      b. Approved equal

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.

b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

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

C. Wire: 0.080-inch nickel-copper alloy.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. C & F Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation on pipe systems subsequent to testing and acceptance of tests.

B. Repair or replace damaged existing insulation as indicated or required.

C. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties. 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 and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

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

H. Provide continuous insulation through hangers, straps and all other supporting members.

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

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

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

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

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

N. Keep insulation materials dry during application and finishing.

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

P. Install insulation with least number of joints practical.

Q. Provide aluminum jacketing around all piping and fittings that are exposed exterior to the building.

R. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers.

S. Install protective metal shields and thermal hanger shield inserts at all supporting members to prevent compression of insulation. Refer to Section “Hangers And Supports For HVAC Piping And Equipment.”

T. Flexible Closed Cell Elastomeric Installation: Slide full sections of insulation onto pipe. Do not slit pipe to fit around piping. All edges shall be clean cut. Insulation shall be pushed onto pipe, never pulled. All seams and butt joints shall be adhered and sealed using adhesive equal to Armaflex 520 Adhesive.

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

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

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

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

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

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

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

AA. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

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

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

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

3.5 GENERAL PIPE INSULATION INSTALLATION

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

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and

unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

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

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

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

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

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

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

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

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

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

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:
   1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
   2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.

3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

A. Pipe Insulation with ASJ,or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

3.12 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.

3.13 PIPING INSULATION SCHEDULE, GENERAL

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

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.14 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

B. Condenser-Water Supply and Return:
1. NPS 4 and Smaller: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

C. Heating-Hot-Water Supply and Return, 90 Deg F to 250 Deg F:
1. NPS 1-1/2 and Smaller: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.
2. Larger than NPS 1-1/2: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

D. Refrigerant Suction and Hot-Gas Piping:
1. Insulation shall flexible elastomeric be the following minimum thickness:
a. NPS 3/4 and smaller: 3/4 inch thick.
b. NPS 1 to NPS 4: 1 inch thick.
c. Greater than NPS 4, 1-1/2 inch thick.
2. For ductless split systems insulate refrigerant suction and liquid lines between evaporators and condensing units. Insulate each line separately.
3. For refrigeration suction lines, insulate between evaporators and compressors.

E. Refrigerant Suction and Hot-Gas Flexible Tubing:
1. Insulation shall flexible elastomeric be the following minimum thickness:
a. NPS 3/4 and smaller: 3/4 inch thick.
b. 1” NPS to 4” NPS: 1 inch thick.
c. Greater than 4” NPS, 1-1/2 inch thick.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:
1. All Pipe Sizes: Insulation shall be the following:
a. Flexible Elastomeric: 2 inches thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.

D. Piping, Exposed indoors:
   1. PVC

E. Piping, Exposed in Mechanical Rooms, etc..:
   1. PVC.

F. Piping, Exposed outdoors:
   1. Aluminum, Smooth

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
   1. Painted Aluminum, Smooth: 0.016 inch thick.

END OF SECTION 23 07 19.00

SECTION 23 09 00.13 – STAND ALONE HVAC CONTROLS

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. General Provisions
   1. The general provisions of the Contract, including the General Conditions and supplemental General Conditions, apply to the work specified in this section.
   2. This Contract is for all labor, materials and equipment required for the complete construction and installation of complete and functioning controls for HVAC equipment.
   3. The systems shall be complete in all respects, tested and ready for operation.

B. General Instructions
   1. Submit a (Base) Bid which will include all hardware and software, electronic and control equipment, sensors, valves, dampers and thermostats, as shown on plans and specified.
   2. In general, the proposal shall be based on a complete Control system, including controllers, valves damper actuators, relays, wiring and tubing and a full DDC system. Provide full commissioning of this equipment.
   3. This contractor shall be prepared to make a personal presentation of his systems to the Owner or his designated representatives prior to award of Contract should the Owner request it.

C. Scope
   1. The HVAC controls systems shall be supplied and installed completely under this Contract. Components shall be mounted and wired by the HVAC contractor.
   2. The engineering, installation, calibration, software programming, and checkout necessary for complete and fully operational systems, as specified hereafter, shall be provided by the HVAC contractor.
   3. The HVAC contractor shall provide low voltage power wiring as required for wiring each individual control component. Power wiring shall be located within the same room as the equipment or within 20 feet of the connection. Electrical contractor shall install wiring according to Division 26.

D. System Description
   1. Furnish all labor, materials, equipment, and service necessary for a complete and operating temperature control systems, utilizing electronic interfaces and actuation devices, as shown on the drawings and as described herein.
   2. Temperature control system to be completely DDC with electronic sensors and electronic actuation of valves and dampers.

E. Work by Others

1. The Electrical Sub-Contractor shall install conduit and connect power wiring. Power wiring and conduit shall be defined as follows:
   a. Wiring of power feeds through all disconnect starters and variable speed controllers to electric motors.
   b. Wiring of 120 VAC emergency power feeds to junction boxes in locations of temperature control panels.
   c. Power wiring to 120 Volt, single-phase motors shown on Electrical Plans and specified in the Electrical Sections.
   d. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by the BAS Contractor.
   e. Conduit for routing temperature control wiring where shown on electrical plans.
   f. Raceways where shown on electrical plans which shall be utilized for temperature control wiring.

F. Related Work
1. Install all line size and non-line size automatic valves and separable wells furnished by the BAS Contractor.
2. Furnish and install all necessary piping connections, taps and wells required for flow, pressure or temperature devices.
3. Provide dampers, if so indicated, under Equipment Specifications.
4. Assemble multiple section dampers with required interconnecting linkages, shafts and brackets and extend the required number of shafts through the ducts for externally-mounted damper motors. Jack shafts will be assembled with sealed roller or ball bearings of stainless steel construction.
5. Provide all Cat 5 cabling, raceways and devices required to connect the BAS server to the owner's Ethernet. HVAC contractor may elect to coordinate this with the electrical contractor or communications contractor. Owner shall provide IP address for BAS. In all cases, this contractor shall be responsible for providing and testing internet connections required for the BAS.
6. HVAC contractor shall coordinate and remain on site with the balancing contractor to operate the facility management system during balancing. The HVAC contractor shall manipulate the system as instructed by the balancing contractor. This shall include but not limited to changing damper positions, valve positions, fan speeds, pump speeds and set points as required to complete the balancing procedures.
7. The installation of motor starters that are not factory installed, thermal overload switches, and power wiring to motors, starters, thermal overload switches, contactors, and electric heating coils is specified in another Division. This Section includes installation of controls plus wiring for automatic controls, electric damper and valve operators, terminal control units, interlocks, starting circuits, and wiring to power consuming control devices.
8. Area smoke detectors are provided, installed and wired under another Division. Duct smoke detectors shall be installed under this Division, but furnished and wired into the fire alarm system under another Division. This Section includes wiring alarm signal relays, provided and installed under another Division.

1.3 SUBMITTALS

A. All submittals for this section, including product samples, shall be reviewed and approved by owner.

B. Specification Compliance Review (Submit with Submittals)

1. Supply, at the time of submittals, a paragraph by paragraph specification compliance report to the Owner. The report shall indicate for each paragraph, how the Contractor meets the criteria of the paragraph.
2. The following format must be utilized in completing the compliance report:
   a. Comply - without exception.
   b. Qualify - Meet the functional intent. For each paragraph, the Contractor shall identify all differences in specific functions stated in the given paragraph and provide a description of what is excluded or how the qualifying system will meet the function specified.

C. Diagrams:
1. Provide separate diagrams for each system, including piping, motor starting and interlock wiring, push buttons, control wiring, interior electrical circuits of control instruments with terminal designations, control motors, colors of wires, locations of instruments and remote elements, and normal position of valves, dampers, relays control points list and sample graphic screen shots.
2. A detailed description of the operation of the control system including device designations shall accompany the drawings. Schedule of dampers including size, leakage, and flow characteristics and a schedule of valves including close-off and flow characteristics shall also be furnished for the entire project.

D. DDC system data:
1. Provide manufacturer's data sheets on the DDC panels, sensors, control interface devices, terminal control units, protection devices, and software.
2. Provide the actual physical proposed room thermostat/temperature sensor and guards, at the time of submittal review, to both the Engineer and Owner for approval.
3. Complete field wiring diagram with terminals labeled as they will be marked on the equipment, including sensors, control and power wiring for each sensor, control and DDC panel.
4. Floor plans locating DDC panels and terminal control units coordinated with work of other trades.

E. All submittal information (drawings and cut sheets) shall be furnished in electronic format and paper upon request.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC control systems to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Refer to Section 23 09 93 and the drawings for all work to be included in the controls work.

B. All materials, equipment and apparatus shall be new and of first-class quality.

C. The contractor must be able to respond to any warranty or service call within 8 hours.

D. Electrical Components, Devices, and Accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

F. Comply with National Electric Code, ULC, and FCC Part 15, subpart J, Class B Computing Devices.

1.6 DELIVERY, STORAGE AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to manufacturer of that equipment.

1.7 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor-Control Centers," "Panelboards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.

C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.

D. Coordinate with Owner's IT department for IP addresses and access to Owner's existing high speed Intranet.

1.8 INSTRUCTION OF OPERATING PERSONNEL

A. General:
   1. Conduct formal instruction sessions for operating personnel.
   2. Obtain direction from the Owner on which operating personnel shall be instructed in each system.

B. Training
   1. Provide 1 formal training session. Such training session shall include but not be limited to:
      a. Basic instruction
      b. Operation and use of advanced features
      c. Optimization and energy management features.
   2. The session shall be conducted by factory-trained personnel and be a minimum of [**four (4) four (4) hour days, for a total of 16 training hours**]. Provide materials and training for up to 3 operators per session to be designated by the Owner.
   3. Provide CD-ROM format recording of training sessions. CD shall include an easy to use index of training segments with extensive description for quick, easy references. CD segments shall be created on the owners actual installed system. CD segments shall be

established for each independent task that is covered in the training to reduce the owner's review time.

4. Obtain a receipt acknowledging completion of each item of instruction.

1.9 SEASONAL ADJUSTMENTS

A. Visit each Building during the first heating or cooling season approximately 6 months after the date of substantial completion to make repairs and adjustments to provide uniform conditions throughout. [**Each visit shall consist of a minimum of one (1) day**]. Schedule the visit for the heating cycle during the months of October through November, and for the cooling cycle during May through June.

B. During each visit:
1. Check and calibrate temperature control devices and thermostats.
2. Test and verify control sequences for proper operation for the season.
3. Modify the system based on the owner's direction.
4. Assist the owner in understanding and clearing any alarms.

C. Prepare and submit a report for each visit documenting conditions found and corrective action taken.

D. Have the Owner sign the report acknowledging the visit.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of controls system that fail(s) in materials or workmanship within specified warranty period.
1. Warranty Period: one year(s) from date of Substantial Completion.

B. When warranty begins this contractor shall send a letter to the Owner and copy the architect and engineer stating that the work is complete per the drawings and specifications and the warranty is to start at one date and end at another.

C. Any equipment, software, or labor found to be defective during this period shall be repaired or replaced without expense to the owner.

D. The contractor must respond to any warranty or service call within 24 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide Automatic Temperature Control systems manufactured and installed by one of the following:
1. From equipment manufacturer
2. Invensys
3. Honeywell

4. Trane
5. Siemens
6. Delta Controls
7. Schneider Electric
8. Alerton

2.2 GENERAL

A. Provide a complete system of direct digital controls (DDC) and monitoring points as specified herein. The DDC system shall interface with the electric and electronic systems to provide control outputs and monitoring inputs to the DDC systems as specified in other Division 23 sections, and as listed in the I/O summaries.

B. The Building Automation System shall improve HVAC reliability and enhance building efficiency while providing an easy to use interface for monitoring and managing the building. The Building Automation System shall provide the necessary Hardware, Software, and Network Communication abilities to provide Scheduling, Monitoring, Trending, Historical Storage, and alarm functions for the HVAC equipment and systems as describe in this specification. Control capabilities shall include but are not limited to: Time of Day scheduling, Direct Digital Control, Custom Control, Boolean Logic, Optimum Start/Stop, Duty Cycling, Electrical Demand Control, Temperature Control, After Hours Override, Reports and Logs, Trend Prints, Remote Communications, Alarm Logging, Run Time and Maintenance, and Expanded Informational Messages.

C. The Building Automation System shall allow full user operation with a minimum of training. It shall have an English language display, with both user prompts and "help" user tutorial. It shall contain management reports for the monitoring of both current and historical energy usage, heating and cooling degree day, building status and after hours occupancy information.

D. All applications programs shall be pre-engineered and pre-tested.

2.3 CONTROL UNITS GENERAL

A. Provide an adequate number of control units to achieve monitoring and control of all data points specified and necessary to satisfy the sequence of operation for all mechanical systems shown on the plans. Provide a minimum of one separate LonMark™/LonWorks™ or BacNet controller for each AHU or other HVAC system. Multiple DDC controllers may control one system provided that all points associated with individual control loops are assigned to the same DDC controller. If multiple controllers are furnished, the contractor must make sure that corresponding outputs and inputs are on the same controller. Extra controllers will be required to ensure that all control outputs are controlled by a controller that has the control inputs directly connected to it. Points used for control loop reset such as outside air or space temperature are exempt from this requirement. When multiple controllers are used for controlling one system, the controllers shall be identical. To minimize the number of spare parts that the owner will need to stock in the future, the same part number controller shall be used for all major system applications (i.e. AHUs, heating water system, chilled water system, pump systems, etc.). All analog ouputs shall be true AO (0-20mA or 0-10Vdc). Floating, pulse-width or phase-cut modulating outputs will not be acceptable for this project. Each of the following panel types shall meet the following requirements.

B. Controllers shall be suitable for the anticipated ambient conditions.
   1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at -40°F to 140°F and 5 to 95% RH, non condensing.
   2. Controllers used in conditioned ambient space shall be mounted in dust-proof enclosures, and shall be rated for operation at 32°F to 122°F and 5 to 95% RH, non-condensing.

C. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

D. Memory: The Control Units shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

E. Diagnostics: The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall assume a predetermined failure mode and generate an alarm notification.

F. Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

G. Automatic staggered restart of field equipment after restoration of power and short cycle protection is required.

2.4 MISCELLANEOUS

A. Materials
   1. All materials and equipment used shall be standard components, of regular manufacture for this application.
   2. All systems and components shall have been thoroughly tested and proven in actual use.

B. Control Valves
   1. General:
      a. Control valves shall be two-way or three-way pattern as required by Sequence of Operation, refer to Specification Section 23 09 93, and shall be constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials.
      b. Control Isolation Valves and Control Two Position Valves shall be line size full port valves.
      c. Valves with size up to and including 3" shall be screwed connections with 150 psi ANSI pressure body rating. Valves 4" and larger shall be flanged configuration.
      d. Two-way control valves shall exhibit equal percentage characteristics. Non-equal percentage valve characteristics shall not be acceptable. Two-position control valves shall be line size and shall be provided with a 150 psi static pressure body rating.
      e. Proportional control valves shall be sized for a maximum pressure drop of 4.0 psig at rated flow (except as noted).

f. Control valves on heating coils for air handling units that introduce outside air shall be spring return type, normally open on power failures and freeze conditions.
g. Globe valves are required for HRU and AHU heating and / or cooling applications.

2. Terminal Unit Control Valves:
   a. Constructed of 360 psi forged yellow brass body, nickel plated brass ball, with optimizer insert for modulating applications, blow-out resistant stem, two- or three-port as indicated, and threaded ends for chilled or hot water, up to 50% glycol solutions.
   b. Spring return is required for all Unit Ventilator heating valves and other terminal equipment that have an outside air source.
   c. All non-spring return valves must have manual override ability built in to the actuator.
   d. Rating: ANSI class IV, maximum static pressure of 360 psig, minimum fluid temperature of 20ºF and maximum of 250ºF operating conditions.
   e. Sizing: 4 psig maximum pressure drop at design flow rate, rated to close against pump shutoff head.
   f. Flow Characteristics: Two-way and three-way valves shall have equal percentage characteristics.
3. Actuators:
   a. Actuators for AHU, VAV, HRU and FCU valves shall be the same as specified below for dampers and shall have the same warranty.
   b. Hydraulic actuators are not acceptable for any application for this project.
4. Manufacturer:
   a. Control valves shall be Belimo, Delta or Invensys electronic ball valves and Belimo or Invensys Globe valves for modulating applications. Belimo or Invensys Butterfly valves are acceptable for large flow applications, (ie. cooling tower, chiller).

C. Motorized Control Dampers
1. General:
   a. Blades shall be 16 gauge minimum and 6 " wide maximum and frame shall be of welded channel iron. Dampers with both dimensions under 18" may have strap iron frames. Dampers over 48" wide shall be equipped with a jack shaft to provide sufficient force throughout the intended operating range.
   b. Dampers shall be black enamel finish or galvanized, with nylon bearings.
   c. Blade edge, tip and jamb seals shall be included for all dampers. Leakage through the damper shall not exceed 10 CFM per square foot at 4" w.g. (based on a 48" x 48" test sample).
   d. Motorized dampers shall be parallel blade for two-position control and opposed blade for proportional control applications.
   e. All motorized dampers throughout the project shall be wired by the Temperature Controls Contractor. Refer to the fan and mechanical schedules, drawings, and control specifications for quantity of motor operated dampers.
2. Damper Actuators
   a. Electronic damper actuators shall be properly sized to provide sufficient torque to position the damper throughout its operating range. All actuators operating in series or parallel to another actuator or in an open loop, such as minimum percentage outside air, shall be equipped with a positive positioning device. Provide spring return type actuators on outside air (close), return air (open), and relief air (close) dampers.

b. Actuators for all dampers and AHU and VAV valves shall be manufactured by Invensys (Duradrive), Siemens (OpenAir) or Belimo. The manufacturer must include a five year warranty from the manufactured date for the actuator. In addition to the 1 year material and labor warranty, the manufacturer shall include a $50 satisfaction guarantee for each actuator to cover the labor cost for the replacement of an actuator if it fails or if the owner is not satisfied with the performance at any time during the 5 year warranty period.

3. Manufacturer:
   a. Dampers shall be manufactured by Ruskin, Greenheck or Tamco.

D. [Temperature Sensors/Transmitters

1. The space temperature sensor shall be located as shown on the drawings. Provide a room sensor with digital readout of temperature. The space temperature sensor shall contain a push-button for override of unoccupied conditions and a plug-in communications jack for connection of the portable editing device to the Lon or BacNet bus.

2. The space temperature sensor shall be capable of displaying setpoints & temperatures in either 1-degree increments or 0.1-degree increments and space temperature an accuracy of +/– ½ degrees. The space temperature sensor shall provide unoccupied override with cancel. The override time shall be user settable from 1 minute up to 7 days. For 1 minute to 16 hours the user shall be able to select any one minute interval.

3. Sensors shall be RTD or Thermistor type, providing a linear OHM per degree F characteristic change, and shall be housed as required for the application.

4. Averaging temperature sensors shall be used for supply air and mixed air applications and shall be a minimum of 22 feet long for locations greater than 16 square feet and a minimum of 5 feet long for locations less than 16 square feet.

5. Temperature ranges shall be selected as required for the application and all sensors shall be +/-1 deg. F.]

E. [Thermostats

1. The thermostat shall be located as shown on the drawings. Provide a thermostat with digital readout of temperature with integral room setpoint adjustment. The thermostat shall contain a push-button for override of unoccupied conditions, up and down arrows to scroll through attributes, and enter key to make changes and a plug-in communications jack for connection of the portable editing device to the Lon or BacNet bus.

2. The thermostat display shall be capable of full programmability of the unit controller without the use of a portable editing device. The thermostat shall be capable of showing the unit controller time and day of week. The display shall be capable of displaying setpoints & temperatures in either 1-degree increments or 0.1-degree increments and space temperature an accuracy of +/– ½ degrees. The thermostat shall provide unoccupied override with cancel. The override time shall be user settable from 1 minute up to 7 days. For 1 minute to 16 hours the user shall be able to select any one minute interval.

3. The thermostat shall provide password protection with user access codes and automatic time-out. The access levels of the thermostat shall provide 3 levels of access within the system.

4. Thermostats shall be RTD or Thermistor type, providing a linear OHM per degree F characteristic change, and shall be housed as required for the application.

5. Temperature ranges shall be selected as required for the application and all sensors shall be +/-1 deg. F.]

F. [Sensor/Thermostat Guards

1. Thermostats and room temperature sensors shall have exposed setpoint adjustment +/- 3 degees on either side of setpoint established at the BAS. Guards are to be smoked-clear Lexan for all sensors/thermostats located in [corridors, restrooms and gymnasiums]. Guards shall be equal to Uni-Gard Inc model UG-2SC or UG-3SC. Provide one guard for all wall mounted sensors in a room.]

G. [Humidity Sensors

1. Humidity sensors shall be digitally profiled thin-film capacitive (32 bit mathematics) type with accuracy of + / - 2% over an operating range of 0 – 100% for outside air, room and duct applications. The stability shall be + / - 1 % annually, for two years. The output signal shall be 4-20 mA or 0-5V / 0-10V.

2. Where required, an RTD or thermistor temperature sensor shall be incorporated into the humidity sensor housing.

3. **The sensing element shall be calibration free and replaceable.**]

H. [Combination Thermostat/Humidistat

1. The temperature and humidity combination stats shall be housed in a single housing and located as shown on the drawings where humidity is required. Two separate sensors will not be allowed. Provide a combination thermostat/humidistat with integral room setpoint adjustment. The combination thermostat/humidistat shall contain a push-button for override of unoccupied conditions, up and down arrows to scroll through attributes, and enter key to make changes and a plug-in communications jack for connection of the portable editing device to the Lon bus.

2. The combination thermostat/humidistat shall be capable of showing the unit controller time and day of week. The display shall be capable of displaying setpoints & temperatures in either 1-degree increments or 0.1-degree increments and space humidity at an accuracy of +/– 2%. The combination thermostat/humidistat shall provide unoccupied override with cancel. The override time shall be user settable from 1 minute up to 7 days. For 1 minute to 16 hours the user shall be able to select any one minute interval.

3. The combination thermostat/humidistat shall provide password protection with user access codes and automatic time-out. The access levels of the sensor shall provide 3 levels of access within the system. The combination thermostat/humidistat shall provide a user access which provides a minimum of 4 attributes which shall include space temperature, setpoint, discharge air temperature leaving the terminal unit, and the space humidity. In addition, with a service level access, the operator shall be able to view and modify a minimum of 8 additional attributes to perform air balance, system verification and checkout and perform diagnostics on the system.

4. **Selected box groups as defined by the engineer or owner (media, computer rooms, and cafeteria) shall all be enabled when the override button is pushed for night setback.**]

I. [Carbon Dioxide Sensors

1. Carbon dioxide sensors shall be Non-dispersive infrared (NIDR) type with a measurement range of 0-2000 ppm, repeatability of + / - 20 ppm and a measurement accuracy of + / - 75 ppm.

2. The recommended calibration interval shall be at least five years.

3. **Duct applications shall have a gas sampling tube and room applications shall utilize diffusion through an attractive, satin finish, high impact plastic housing.**]

J. [**Chiller and Elevator Equipment Rooms Thermostats**

1. Electric thermostats shall be single temperature bi-metal element type, fast responding, with a range of 55-85 deg. F.

2. **Thermostat covers shall be locking type with concealed setpoint adjustment and thermostat differential shall be fully adjustable.**]

K. [Low Limit Thermostats

1. Low limit thermostats shall be automatic reset type and a minimum of 20 feet in length responding to the lowest temperature on any one foot of the element. Provide necessary quantity of thermostats to protect the coil adequately from a potential freeze condition (minimum of one low limit thermostat per 20 square feet of coil).

2. When a low limit condition is sensed the fan will stop, the AHU heating valves will go full open, outside air dampers and relief air dampers will go full closed, the return air damper will go full open, the DDC system shall be alarmed, and the heating pumps will speed up as required to handle the additional flow load.

3. Provide software to lock out the unit if the low limit trips and resets itself three times without being reset by an authorized operator through the BAS.]

L. [Static Pressure Sensors

1. Pressure sensors shall be commercial grade quality with +/- 1 % accuracy and shall produce a 4 20 ma or 0-5 vdc output over the range of the sensor. The range shall be field adjustable and selected to utilize the smallest possible range that will sufficiently cover the range required for normal operating conditions.

2. Pressure sensors shall contain digital displays.]

M. [High Static Limits

1. Limits shall be manual reset type static limits, and shall be mounted on the discharge side of the supply fan on variable volume systems. The sensor will stop the fan if its limits are exceeded.]

N. [**Water Differential Pressure Transmitters**

1. Water differential pressure transmitters shall be commercial grade quality with +/- 1% accuracy over the full scale with built-in surge dampening for high stability.

2. The transmitter shall be able to withstand two times the full scale range without damage.

3. The range shall be field adjustable and selected to utilize the smallest possible range that will sufficiently cover the range required for normal operating conditions.

4. The sensor shall incorporate a pushbutton for auto-zero calibration.

5. **Bypass valve manifolds shall be furnished by BAS contractor when needed.**]

O. [**Flow Switches**

1. **When flow switch status is indicated in the points list, it shall be detected through a water or air flow switching device that is capable of detecting flow for ensuring that fan or pump is operational.**]

P. [Current Sensing Status Switches

1. When status is indicated in the points list, it shall be detected through a current sensing status device that is capable of detecting flow of current to motors to determine accurate and reliable status. The current sensing amperage range shall be selected based upon the motor to be monitored.]

Q. [Flow Meters with Transducers

1. Flow meters with transducers shall be installed where indicated on the Drawings or required in the sequence of operation and wired by the Temperature Control Contractor.

2. The flow transducers shall utilize a nonmagnetic sensing mechanism with a forward-swept rotating impeller to produce a frequency signal proportional to flow. The flow transducers shall have an achievable accuracy of +/-1 percent of flow rate with flow velocities of 1 to 30 fps.

3. The flow meter shall be constructed of brass with a glass reinforced impeller, tungsten carbide shaft and glass reinforced polyphenylene sulfide housing. The unit shall be both insertable and removable through a gate type valve when the pipe is under pressure.

4. Provide minimum of 10 straight pipe diameters upstream and 5 diameters downstream for each field installed flow transducer.

5. Provide an insertion/extraction tool to allow removal and replacement of flow transducer while the system is under pressure.]

R. [Airflow Monitoring Stations

1. General: Provide electronic airflow monitoring stations to measure and control airflow with separate air flow measuring device and separate damper for control.

2. Signal: Device shall provide a 4-20 mA signal for converting to exact airflow. Unit shall be calibrated to measure exact airflow through the entire range of values from 0 to 100% flow.

3. Probes: Provide multiple probes as required to measure airflow. Verify with air balance in field and adjust and add probes as required to maintain exact airflow measurement.

4. Sensors: Provide multiple sensors per probe as recommended by manufacturer according to dimensions. Provide on glass encapsulated self heated thermistor and one glass encapsulated thermistor temperature sensor for each sensing point.

5. Support Struts and Support Bracket: Tubular aluminum extrusion.

6. Enclosure: Provide aluminum enclosure for indoor use and Nema 4 enclosure for outdoor use.

7. Airflow station shall be thermal dispersion technology or equivalent performance and equal to Ebtron GTx116-P for duct and plenum applications

8. Airflow station shall communicate with LON, Bacnet or Modbus and be open protocol.

9. Fan inlet measurement devices are not acceptable.

10. Manufacturer: Subject to compliance with requirements, provide airflow measuring stations of one of the following:

a. Ebtron
b. Kele
c. Paragon Controls
d. Ruskin Mfg. Co.
e. Tek-Air Systems Inc.
f. **Ultratech Industries**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine products and material before installation. Reject products or materials that are wet, moisture damaged, or mold damaged.

C. Examine walls, floors, roofs, equipment for suitable conditions where controls will be installed.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 CONTROL DEVICES AND WIRING

A. [Low Voltage Temperature Control Devices
1. Low voltage thermostats shall be furnished, installed and wired by the HVAC contractor.
2. The electrical contractor shall provide 4" square by 1-1/2" deep wall outlet boxes (with single-gang rings) for all thermostats/sensors. The electrical contractor shall provide one ¾" empty conduit from each thermostat/sensor location, turned out above accessible ceilings (in joist space or against overhead slab/deck).
3. The HVAC Contractor shall provide all other necessary conduit, raceway and wiring related work. Conduit shall be identified in ceiling cavity and shall be provided with sweep bends, bushings and drag line.
4. The HVAC Contractor shall coordinate with the General Contractor to ensure thermal envelope is maintained at these locations.]

B. [Line Voltage Temperature Control Devices
1. The electrical contractor shall provide 4" square by 1-1/2" deep wall outlet boxes (with single-gang rings) for all thermostats.
2. The electrical contractor shall provide line voltage power wiring, from thermostat outlet box to equipment that is to be controlled by the thermostat, in ¾" conduit.
3. Provide with a contactor to shut fans and close valve through the DDC system.
4. The HVAC Contractor shall coordinate with the General Contractor to ensure thermal envelope is maintained at these locations.]

C. [120VAC Temperature Control Circuits
1. Electrical Contractor shall provide all 120 Volt power wiring as required for temperature control panels and transformers to low voltage. Electrical Contractor shall connect to existing spare at electrical panel board and provide proper circuit breaker per NEC and label panel board accordingly.
2. All other required 120VAC raceway and wiring related work shall be provided by the Electrical Contractor.
3. The Electrical Contractor shall coordinate with the General Contractor to ensure thermal envelope is maintained at these locations.]

D. General Control Wiring Requirements and Installation Methods

1. Except where specifically indicated otherwise herein or within Division 23 specifications, the HVAC/Temperature Control Contractor shall provide all electrical work as required for all temperature control related wiring (i.e. conduit, raceway, outlet boxes, junction boxes, wiring, etc.) in accordance with Division 26 requirements. All conduit shall be 3/4" minimum.
2. Coordinate all thermostat/sensor locations in field (case by case) with Architect, Owner and Electrical Contractor to ensure that they are placed in locations that will not interfere with furniture, equipment, artwork, wall-hung specialties, room finishes, etc. All thermostat/sensor wall locations indicated on HVAC drawings are schematic only and must be verified case-by-case prior to rough-in.
3. All electrical work as described in this specification shall be per the latest edition of the National Electrical Code (NEC) and per applicable state and local codes. Refer to Division 26 specifications for required installation methods and follow Division 26 requirements as related to low voltage and communication technology system cables.
4. Where "free-air" installation methods (either exposed above the ceilings, in bridle rings or in cable trays) are permitted under Division 26 above ceilings, provide plenum-rated cables wherever plenum ceilings (if any) exist and install as defined under Division 26. Install low voltage circuits, located in concrete slabs and masonry walls, or exposed in occupied areas, in electrical conduit regardless of what wiring methods are permitted under Division 26.
5. Where cable trays or bridle rings are provided by the electrical contractor for low voltage cables, these raceways may be utilized for control wiring by this contractor (provide special color coded jackets, label cable jackets per Division 26 and group control wiring cables together). Provide conduit drops from cable tray/bridle ring paths to wall outlet boxes and equipment unless directed otherwise under Division 26.
6. Regardless of permitted methods in Division 26, all cables/wiring installed concealed by gypsum board, masonry or other inaccessible materials in walls or above ceilings shall be installed in conduit, ¾" minimum.
7. All conduit, bridle rings, raceway, outlet boxes, etc. necessary for complete operational installation of control wiring shall be provided (furnished and installed) by the temperature control contractor in strict compliance with Division 26 documents. Coordinate all work with all other applicable trades including the electrical contractor.
8. Provide all required conduit work to and between equipment in a manner compliant with that described above (i.e. between VAV boxes, to boilers, starters, condensing units, etc. as applicable).
9. Install control wiring without splices between terminal points, color-coded. Where a splice is required, install within junction box. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and per Division 26.
10. Install circuits over 25 volt with color-coded No. 12 wire in electrical metallic tubing, per Division 26. Install circuits under 25 volt with color-coded No. 18 wire with 0.031" high temperature (105 degrees F) plastic insulation on each conductor and plastic sheath over all. Install electronic circuits with color-coded No. 22 wire with 0.023" polyethylene insulation on each conductor with plastic-jacketed copper shield over all.
11. All control cabling shall be labeled at both ends with descriptive information of control device.

3.3 OPERATING AMBIENTS

A. Electronic controls mounted in unconditioned space shall be rated for ambient operating conditions of –40 degree F to +140 degree F.

B. Controls not meeting these limits shall be mounted in an accessible location within conditioned space.

3.4 COMMISSIONING

A. Automatic Temperature Controls
   1. Wiring and tubing shall be identified with the same numbers and symbols as used on the corrected, approved record diagrams.
   2. Label control apparatus with nameplates or valve tags bearing the functional designations shown on approved control diagrams.

B. Operation and Maintenance Manuals
   1. Submit on disk in electronic format using Adobe PDF
      a. Include marking or tagging of specific models and options used on the project.
      b. All schedules shall be submitted in Microsoft Excel or comma delimited format.
      c. All drawings be submitted in AutoCAD DWG or DXF format.
   2. Submit manuals 1 month before systems start-up and commissioning.
   3. General Contents
      a. Title page with project name, contractor's and subcontractors' names, addresses and telephone numbers.
   4. Index Sheet
      a. Manufacturers' operating and maintenance manuals, including parts lists for each piece of equipment and accessories requiring service or maintenance, the warranty period, and the name, address, and telephone number of the nearest sales and service organization for each item.
      b. Complete description of functions and operation of each piece of equipment including descriptions of how equipment operates in conjunction with automatic control systems, and instruction for cleaning, lubrication, and maintenance.
      c. Descriptive information:
         1) Function or service.
         2) Classification.
         3) Design capability.
         4) Performance characteristics.
         5) Principal components.
         6) Distribution arrangement.
         7) Schematic diagram.
         8) Control diagram.
      d. Equipment data:
         1) Materials of construction.
         2) Parts designation.
         3) Manufacturer and model number.
         4) Size and rating.
         5) Pressure, speed, and temperature limitations.
      e. Inspection and maintenance information:
         1) Inspection schedule and checklist.
         2) Schedules and procedures for lubrication, replacement, adjustment, cleaning, painting, protection and testing.

3) Standard forms for compiling inspection and maintenance records.
4) Inspection during operation.
5) Adjustment and regulation.
6) Operational test procedures.
7) Detection of malfunction.
8) Precautions.
9) Troubleshooting.

f. Step-by-step procedure for starting, stopping, an operating each system:
1) Starting and stopping procedures.
2) Adjustment and regulation.
3) Seasonal changeover.
4) Seasonal shut down.
5) Seasonal start-up.
6) Logs and records.

g. Copies of inspection certificates provided by the city, county, state and insurance companies.
h. Approved start and completion dates of the guarantee period.
i. Valve schedules and diagrams.
j. Point to point document for all control and monitoring points.

C. HVAC
1. Control System
a. Control diagrams including electric and interlock wiring.
b. Final installed control software listings and flow charts. Listings shall include English comment lines documenting purpose of each group of executable statements and relationship to control sequence for ease of future troubleshooting and modification.
c. Record data base information.
d. Point identification and sensor characteristics.
e. As-built wiring diagrams.
f. Central station operator's manuals and software documentation.
g. Contents shall be type written.

D. DOCUMENTATION
1. Submit the following certificates, statements, receipts, and reports as specified herein:
2. Record drawings.
3. Submittals.
4. Operation and maintenance manuals.
5. Certification of controls calibration and testing.
6. Receipts for controls training.
7. Receipt acknowledging no controls failures during test period.

E. RECORD DRAWINGS
1. Record drawings shall include the manufacture and model number of equipment indicated in schedules on the Drawings.
2. Reproductions of design drawings shall not be used in the preparation of record drawings.
3. All record drawing information (drawings and cut sheets) shall be furnished in an electronic format.

3.5 MAINTENANCE

A. Equipment operated prior to the date of substantial completion shall be maintained in accordance with manufacturer's recommendations.

3.6 EQUIPMENT START-UP AND CHECK-OUT

A. General
   1. Verify readiness for start-up of each item of equipment on the basis of inspection.

B. Automatic Temperature Controls
   1. The system manufacturer shall provide the services of control technicians at start-up to check-out the system, input data supplied by the Owner, and place the system in operation. Manufacture shall verify proper operation of each item in the sequences of operation, including hardware and software.
   2. Check-out each system for control function through the entire sequence. Check actuator travel on dampers and valves for action and extent. Check calibration of instruments.
   3. Verify that control dampers open and close completely.
   4. Calculate and verify instrument setpoints.

C. Controls Acceptance Conditions
   1. Calibration and testing: Calibrate equipment and verify operation before the system is placed on-line. Check each control point, within the system by making a comparison between the control command at the operator console and field-controlled device. BAS control loops, interlocks, sequences, energy management programs, and alarms shall be tested and stable operation verified. Control loop parameters and tuning constants shall be adjusted to produce accurate, stable control system operation. Before obtaining permission to schedule the acceptance test, provide written certification that the installed complete system has been calibrated, tested and is ready to begin acceptance testing.
   2. Acceptance test: Conduct final acceptance test, with the Owner on site, on the complete and total installed and operational automation system to demonstrate that it is functioning in accordance with requirements specified herein. Demonstrate the correct operation of monitored and controlled points as well as the operation and capabilities of sequences, reports, specialized control algorithms, diagnostics, and software.
   3. Final system acceptance will be based on the following items:
      a. Completion of the installation of hardware and software items. Demonstrate complete operation of the system, including hardware and software, with no failures during a 14 consecutive day period. Obtain receipt from the Owner acknowledging no failures within the test period. Submit a daily log documenting failures.
      b. Satisfactory completion of the record drawings, and operating and maintenance manuals.
      c. Satisfactory completion of training programs.

3.7 ACCEPTANCE PROCEDURE

A. Upon completion of the calibration, contractor shall start-up the system and perform all necessary testing and run diagnostic tests to ensure proper operation.

B. Contractor shall be responsible for generating all software and entering all database necessary to perform the sequence of control and specified software routines.

C. An acceptance test in the presence of the Owner's representative or engineer shall be performed.

END OF SECTION 23 09 00.13

SECTION 232113 – ABOVE GROUND HYDRONIC 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 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

1.4 GENERAL REQUIREMENTS

A. Unless otherwise indicated, all materials shall be new and of the best grade and quality for the type specified. Materials shall comply with the “Buy American Act”.

B. Where piping is not indicated on the plans, but is obviously or apparently required, contact the Engineer prior to submission of the bid.

C. All piping shall be capped or plugged during erection as required to keep clean and debris and moisture free.

D. The piping indicated shall be installed complete and shall be of the size indicated. When a pipe size is not indicated, the Contractor shall request the pipe size from the Engineer. Where a section of piping is not indicated but is obviously required for completion of the system, the Contractor shall provide same at no additional cost to the project.

E. Piping shall be installed so as to allow for expansion without damage to the building finishes, structure, pipe, equipment, etc., use offsets, U-bends or expansion joints as required. No mitered joints or field fabricated pipe bends shall be accepted. Pipe shall clear all windows, doors, louvers and other building openings.

F. Insulated piping shall be supported on a rigid insulation block at each hanger so as to prevent crushing of insulation by hangers. Hangers shall pass completely around the insulation jacket and a steel protective saddle shall be applied to prevent compression of the insulation.

G. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes shall not be permitted.

H. In metal buildings or buildings with light gauge trusses, support piping with standard pipe hangers with C-clamp connection to main structural members (not perlins), use angle steel cross pieces between main structural members where required to provide rigid support.

I. Where piping rests directly on a hanger, clip, bracket or other means of support, the support element shall be of the same material as the pipe, (e.g., copper to copper, ferrous to ferrous, etc.) or shall be electrically isolated one from the other so as to prevent pipe damage by electrolysis. Pay particular attention and do not allow copper pipe to rest on ferrous structural members, equipment, etc. without electrolytic isolation. This includes temporary support required during Construction.

J. Pipe shall be cut accurately to measurements established at the building by the Contractor and worked into place without springing or forcing. All pipes shall be reamed to full pipe diameter before joining and before assembling. All lengths of pipe shall be set vertically and tapped with a hammer to remove scale and dust and inspected to insure that no foreign matter is lodged therein.

K. All hot and cold water piping shall be kept a sufficient distance apart so as to prevent heat transfer between them. Cold water piping shall also be kept apart from refrigerant hot gas lines.

L. Piping carrying water or other fluids subject to freezing shall not be installed in locations subject to freezing without a means of freeze protection. If in doubt, consult Engineer.

M. Pay particular attention to conflict of piping with other work. Do not install until conflict is resolved. If in doubt, consult Engineer.

N. Piping materials in each system shall, to the extent practicable, be of the same material. Frequent changes of material (for example, from copper to steel) shall be avoided and in no case shall be accomplished without use of insulating unions and permission of the Engineers.

O. Nipples shall be of the same material, composition and weight classification as pipe with which installed.

P. When connecting to an existing hydronic water system (chilled, hot, geothermal, etc.) or domestic water system, the Contractor shall include cost to drain the existing piping system and refill with water/closed loop chemicals to match existing fluid. If the building is occupied, and the drain down will affect services to these occupied areas, then the systems shall be drained and refilled over a weekend at a time acceptable to the Owner.

Q. Tee connections for welded pipe shall be assembled with welding fittings. Where the size of the side outlet is such that a different connection technique than on the run is required, a weld-o-let, sock-o-let, or thread-o-let type fitting may be used for the branch in place of reducing tees only where the branch is 2/3 the run size or smaller. Weld-o-let and thread-o-let branch connections are acceptable.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

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

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube (Hard Copper): ASTM B88, Type L, and ASTM B88, Type M

B. Annealed-Temper Copper Tube (Soft Copper): ASTM B88, Type L

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

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

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

F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

G. Wrought Copper Unions: ASME B16.22.

H. Copper-Tube, Pressure-Seal-Joint Fittings:

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

a. Elkhart Products Corporation.
b. Mueller Industries, Inc.
c. NIBCO INC.
d. Viega LLC.

2. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
3. Minimum 200-psig working-pressure rating at 250 deg F.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.

C. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

D. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

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

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:
1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:
1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.5 DIELECTRIC FITTINGS

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

B. Dielectric Unions:
1. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 150 psig.

c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
1. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 150 psig.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
1. Description:

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

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, NPS 2 and smaller shall be the following:
1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

B. Hot-water heating piping, NPS 2-1/2 and larger shall be the following:
1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Condenser-water piping, NPS 2 and smaller shall be the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

D. Condenser-water piping, NPS 2-1/2 and larger, shall be any of the following:
1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Condensate-Drain Piping, Copper: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

3.2 INSTALLATION OF PIPING

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

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to the Section 232116 "Hydronic Piping Specialties."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

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

T. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

V. Install sleeves for piping penetrations of walls, ceilings, and floors.

W. Install sleeve seals for piping penetrations of concrete walls and slabs.

X. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

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

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

C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

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

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Pressure-Sealed Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.4 INSTALLATION OF DIELECTRIC FITTINGS

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

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

B. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting and coupling.

D. Support vertical runs of copper tubing and steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections.

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES AND VALVES

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 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.5 QUALITY ASSURANCE

A. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong Pumps, Inc.
2. Bell & Gossett; a Xylem brand.
3. Griswold Controls.
4. Hays Fluid Controls.
5. Nexus Valve, Inc.
6. Nibco Inc.

B. Automatic Flow-Control Valves:
1. Body: Brass or ferrous metal.
2. Flow Control Assembly, provide either of the following:

a. Piston and Spring Assembly: Stainless steel tamper proof, self-cleaning, and removable.
b. Elastomeric Diaphragm and Polyphenylsulfone Orifice Plate: Operating ranges within 2- to 80-psig differential pressure.

3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size: Same as pipe in which installed.
6. Performance: Maintain constant flow within plus or minus 10 percent, regardless of system pressure fluctuations.
7. Minimum CWP Rating: 175 psig.
8. Maximum Operating Temperature: 200 deg F.

2.2 AIR-CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMTROL, Inc.
2. Apollo Valves; a part of Aalberts Integrated Piping Systems.
3. Armstrong Pumps, Inc.
4. Bell & Gossett; a Xylem brand.
5. Hays Fluid Controls.
6. Nexus Valve, Inc.
7. NuTech Hydronic Specialty Products.
8. TACO Comfort Solutions, Inc.
9. WATTS.

B. Manual Air Vents (use where located above a finished ceiling or space):

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

2.3 STRAINERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Keckley Company.
2. Metraflex Company (The).
3. Titan Flow Control, Inc.
4. WATTS.

B. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 60-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

2.4 ALIGNMENT GUIDES AND ANCHORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Adsco Manufacturing LLC.
2. Advanced Thermal Systems, Inc.
3. Flex-Hose Co., Inc.
4. Flexicraft Industries.
5. Flex-Weld, Inc.
6. Hyspan Precision Products, Inc.
7. Mason Industries, Inc.
8. Metraflex Company (The).

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

C. Anchor Materials:

1. Steel Shapes and Plates: ASTM A36/A36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
3. Washers: ASTM F844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

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

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

a. Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
b. Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
c. Washer and Nut: Zinc-coated steel.

2.5 STACK-SLEEVE FITTINGS

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

1. Jay R. Smith Mfg Co; a division of Morris Group International.
2. Zurn Industries, LLC.

B. Description: Manufactured, galvanized cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews..

2.6 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. Airex Manufacturing.
3. CALPICO, Inc.
4. GPT; an EnPro Industries company.
5. Metraflex Company (The).
6. Proco Products, Inc.

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Carbon steel
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 of length required to secure pressure plates to sealing elements.

2.7 ESCUTCHEONS

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

1. BrassCraft Manufacturing Co.; a Masco company.
2. Dearborn Brass.
3. Jones Stephens Corp.
4. Keeney Manufacturing Company (The).
5. Mid-America Fittings, Inc.
6. ProFlo; a Ferguson Enterprises, Inc. brand.

B. Split-Plate, Stamped-Steel Type: concealed hinge; and spring-clip fasteners. Coordinate color with room finishes and/or architect. Install on insulated and bare piping in finished spaces.

2.8 VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Valve, Inc.
2. Hammond Valve.
3. Milwaukee Valve Company.
4. NIBCO INC.

B. Ball Valves
1. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two piece.
5) Body Material: Bronze.
6) Ends: Threaded.
7) Seats: PTFE.
8) Stem: Stainless steel.
9) Ball: Stainless steel, vented.
10) Port: Full.

C. Butterfly Valves
1. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
a. Description:
1) Standard: MSS SP-67, Type I.
2) CWP Rating: 200 psig.
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
5) Seat: EPDM.
6) Stem: One- or two-piece stainless steel.
7) Disc: Aluminum bronze.

D. Check Valves
1. Bronze Swing Check Valves with Bronze Disc, Class 150:
a. Description:

1) Standard: MSS SP-80, Type 3.
2) CWP Rating: 300 psig.
3) Body Design: Horizontal flow.
4) Body Material: ASTM B62, bronze.
5) Ends: Threaded.
6) Disc: Bronze.

2. Iron Swing Check Valves with Metal Seats, Class 250:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
      3) NPS 14 to NPS 24, CWP Rating: 300 psig.
      4) Body Design: Clear or full waterway.
      5) Body Material: ASTM A126, gray iron with bolted bonnet.
      6) Ends: Flanged.
      7) Trim: Bronze.
      8) Gasket: Asbestos free

2.9 CONNECTORS

A. Pump Connections
   1. Construction to be of annular corrugated stainless steel close-pitch hose with stainless steel overbraid. The corrugated metal hose, braid(s), and a stainless steel ring-ferrule/band (material gauge not less than .048") must be integrally seal-welded using a 100% circumferential, full-penetration TIG weld. End fittings shall be flat-face plate steel flanges with 150# ANSI drilling and outside diameter. Fittings must be attached using a 100% circumferential TIG weld. Braided stainless steel pump connector(s) must be suitable for operating temperatures up to 850 degrees F. The rated working pressure of the braided metal hose must have a minimum 4:1 safety factor. Each braided stainless steel pump connector shall be individually leak tested by the manufacturer using air-under-water or hydrostatic pressure. Flanged pump connectors shall be prepared for shipment using cut-to-length spacers, securely positioned between the flanges to prevent axial compression damage and maintain the manufactured length. Spacers must be removed prior to system start up.

B. Terminal Equipment Connections: Stainless-Steel Bellow, Flexible Connectors

   1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   2. End Connections: Threaded or flanged to match equipment connected.
   3. Performance: Capable of 3/4-inch misalignment.
   4. CWP Rating: 150 psig.
   5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install packed-type expansion joints with packing suitable for fluid service.

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

D. Install rubber packless expansion joints according to FSA-PSJ-703.

3.2 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

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

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

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

D. Anchor Attachments:

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

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

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

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

3.3 STACK-SLEEVE-FITTING INSTALLATION

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

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated, Horizontal Assembly, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.4 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.5 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

3.6 EXAMINATION

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

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

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

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

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

3.7 VALVE INSTALLATION

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

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

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

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

E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level or installed in a vertical position, as long as the flow arrow on the body points up.

3.8 ADJUSTING

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

3.9 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. CONDENSER-WATER VALVE SCHEDULE
   1. Shutoff Service
      a. Pipe NPS 2 and Smaller: Bronze ball valves.
      b. Pipe NPS 2-1/2 and Larger: Iron, Single-Flange Butterfly Valves

B. HEATING-WATER VALVE SCHEDULE
   1. Shutoff Service
      a. Pipe NPS 2 and Smaller: Bronze ball valves.
      b. Pipe NPS 2-1/2 and Larger: Iron, Single-Flange Butterfly Valves

3.10 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

END OF SECTION 232116

SECTION 232300 - REFRIGERANT 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 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.4 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings, Brazed-Joint: ASME B16.50.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8/A5.8M.

E. Copper-Tube, Pressure-Seal-Joint Fittings for Refrigerant Piping:

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

   a. Conex Banninger - USA.
   b. Parker Hannifin, Sporlan Division.
   c. RLS LLC.

2. Standard: UL 207; certified by UL for field installation. Certification as a UL-recognized component alone is unacceptable.
3. Housing: Copper.
4. O-Rings: HNBR or compatible with specific refrigerant.
5. Tools: Manufacturer's approved special tools.
6. Minimum Rated Pressure: 700 psig.

2.3 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
   1. Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed jointsor pressure-seal-joint fittings.

3.2 INSTALLATION OF PIPING, GENERAL

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

B. Install refrigerant piping according to ASHRAE 15.

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

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

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

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.

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

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. 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.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 PIPE JOINT CONSTRUCTION

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

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

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches of each fitting.

E. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 23 31 13.00 - METAL DUCTWORK

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. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:
1. Section 23 05 03 “Submittals for HVAC”.
2. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.

11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Ductwork Submittal:
1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dixie Sheetmetal
      b. Eastern Sheetmetal of Cincinnati
      c. Lindab
      d. Semco Mfg., Inc.
      e. Hranec

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Fabricated ductwork shall comply with AMCA Standard 511 for air leakage.

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials and duct construction methods unless otherwise

indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting. Exposed ductwork which is to be painted shall have paint grip applied.

D. Exposed Ductwork: Provide paint grip on all exposed ductwork that is required to be painted. Refer to architectural drawings for areas where duct is to be painted. Coordinate with all trades prior to installing paint grip.

E. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

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

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
      a. CertainTeed Corporation; Insulation Group.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Owens Corning.
   2. Maximum Thermal Conductivity:
      1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
      2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

B. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
8. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.

9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

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

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 INSTALLATION OF DUCT LINER

A. General: Install duct liner in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

B. Size of ductwork shown on the drawings is free net area, outside dimension of ducts will need to be increased if lined duct is used.

C. Store internally lined ductwork up off of the floor. Protect internally lined ductwork from water and dust.

D. Shop Application of Duct Liner:
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
   5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
   6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
   7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
   8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
      a. Fan discharges.
      b. Intervals of lined duct preceding unlined duct.
      c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

E. Inspect and repair all damaged lining prior to installation of ductwork.

F. The following ductwork shall be lined:
   1. Return from open ceiling plenum return to HVAC unit.
   2. Transfer Air ducts.
   3. Supply and return between fan discharge and room terminal outlet(s) serving Theater space.

G. The following ductwork shall be lined with flexible duct liner:
   1. Return ductwork in ducted return systems 10 feet downstream of HVAC unit.
   2. Exhaust ductwork 10 feet upstream and downstream of fans.
   3. Transfer air ducts.
   4. Supply and return between fan discharge and room terminal outlet(s) serving Theater space.
   5. Supply air duct 10 feet downstream of VAV box.

H. The following ductwork shall be lined with rigid duct liner:
   1. Return from open ceiling plenum return to HVAC unit.
   2. Field or shop fabricated return air/outside air mixing plenums at HVAC units.

3.4 DUCT SEALING

A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
4. Unconditioned Space, Exhaust Ducts: Seal Class C.
5. Unconditioned Space, Return-Air Ducts: Seal Class B.
6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
8. Conditioned Space, Exhaust Ducts: Seal Class B.
9. Conditioned Space, Return-Air Ducts: Seal Class C.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. All ductwork required to be painted shall be cleaned and oil-free. Mechanical Contractor shall prepare ductwork surfaces accordingly to accept primer and paint.

B. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 09 91 23 "Interior Painting."

C. For any ductwork that conveys corrosive air (science hoods, labs, etc), provide stainless steel epoxy coated ductwork to prevent corrosion.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
   2. Test the following systems:
      a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
      b. Supply Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
      c. Return Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
      d. Exhaust Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
      e. Outdoor Air Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Test for leaks before applying external insulation.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
   6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
   2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   4. Coils and related components.
   5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   6. Supply-air ducts, dampers, actuators, and turning vanes.
   7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
   1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
   4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
   5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
   6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 23 31 13.00

SECTION 23 33 00.00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Manual volume dampers.
2. Motor operated dampers.
3. Fire dampers.
4. Flange connectors.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
a. Special fittings.
b. Manual volume damper installations.
c. Motor operated damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

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

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Air Balance Inc.; a division of Mestek, Inc.
      b. American Warming and Ventilating; a division of Mestek, Inc.
      c. Nailor Industries Inc.
      d. Pottorff.
      e. Ruskin Company.
      f. Vent Products Company, Inc.
      g. Greenheck Fan Corporation.
   2. Standard leakage rating.
   3. Suitable for horizontal or vertical applications.

4. For units less than 36" wide or 12" high
   a. Frame shall be 22 gage galvanized steel.
   b. Blade shall be single skin, 22 gage galvanized steel with center "V" groove for reinforcement.
   c. Bearings shall be corrosion resistant synthetic sleeve type turning in an extruded hole in the damper frame.
   d. Axles shall be 3/8" square shaft positively locked into damper blade.
5. For units over 36" wide and 12" high
   a. Frame shall be 18 gage galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement.
   b. Blades shall be single skin 18 gage galvanized steel with three longitudinal grooves for reinforcement.
   c. Bearings shall be corrosion resistant synthetic sleeve type turning in an extruded hole in the damper frame.
   d. Axles shall be hexagonal positively locked into damper blade.

B. Jackshaft:
1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

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

2.4 MOTOR OPERATED DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Pottorff.
5. Ruskin Company.
6. Vent Products Company, Inc.

B. All louvers, gravity roof ventilators, etc. shall have motor operated dampers. Dampers shall be low leak with blade and edge seals.

C. All motor operated dampers shall be furnished and installed by the mechanical contractor. All damper actuators shall be furnished, installed and wired by the TCC, unless damper & actuator are provided by equipment manufacturer. TCC shall provide all necessary transformers, contactors, controls and wiring for interlocking equipment to motor operated dampers. Frames shall be 5" x 1" x 0.081" minimum thickness, 6063T5 extruded aluminum hat channel with hat mounting flanges on both sides of the frame. Each corner shall be reinforced with two die formed internal braces and machine staked for maximum rigidity.

D. All motor operated dampers integral to or utilized as part of an engineered smoke control system shall be listed and comply with UL 555S.

E. Blades shall be airfoil type galvanized steel with integral structural reinforcing tube running full length of each blade. Blade edge seals shall be extruded vinyl double edge design with inflatable pocket which enables air pressure from either direction to assist in blade to blade seal off. Blades seals shall be mechanically locked in extruded blade slots, yet shall be easily replaceable in field. Adhesive or clip-on type blade seals are not acceptable.

F. Bearings shall be non-corrosive molded synthetic. Axles shall be square to provide positive locking connection to blades and linkage. Round axles are not acceptable. Linkage shall be concealed in frame.

G. All dampers shall be tested in accordance with AMCA 500 and shall be rated AMCA Class 1A for 3.5 cfm/sf at 1” wg pressure for all sizes 24” wide and above.

H. Dampers shall be parallel blade for 2-position control and opposed blade for modulating control.

I. Provide electrical disconnect switch for all electric damper actuators.

J. Motor operated dampers wired to emergency power shall have spring loaded normally closed actuators.

2.5 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. NCA Manufacturing, Inc.
5. Pottorff.
6. Ruskin Company.
7. Vent Products Company, Inc.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Fire Rating: 1-1/2 and/or 3 hours. Refer to drawings.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve:
1. Each fire damper shall include a steel sleeve and retaining angles furnished by the damper manufacturer to ensure appropriate installation.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, galvanized sheet steel. In place of interlocking blades, use full-length, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.6 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Eastern Sheetmetal.
3. Nexus PDQ; Division of Shilco Holdings Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.7 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aero Dyne.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.
4. Elgen Manufacturing.
5. METALAIRE, Inc.
6. SEMCO Incorporated.
7. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.8 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Flexmaster U.S.A., Inc.

3. Greenheck Fan Corporation.
4. McGill AirFlow LLC.
5. Ruskin.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
   d. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Continuous hinge and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Continuous hinge and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches: Continuous hinge and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.Factory set at 3.0- to 8.0-inch wg.
3. Doors close when pressures are within set-point range.
4. Hinge: Continuous piano.
5. Latches: Cam.
6. Seal: Neoprene or foam rubber.
7. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.10 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.
   3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
   1. Pressure Rating: 10-inch wg positive and 1-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 10 to plus 160 deg F.

C. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 10 to plus 160 deg F.
   4. Insulation R-value: Comply with local ASHRAE/IESNA 90.1 requirements.

D. Flexible Duct Connectors:
   1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install motor operated dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel. These dampers, whether shown or the drawings or not, shall be installed at no additional cost to the Owner. Consult with Testing, Adjusting, and Balancing Agency prior to ductwork installation to establish damper locations
   1. Install steel dampers in steel ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream and downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, motor operated dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-foot spacing.
   8. Upstream and downstream from turning vanes.
   9. Upstream or downstream from duct silencers.
   10. Control devices requiring inspection.
   11. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.
   3. Head and Hand Access: 18 by 10 inches.
   4. Head and Shoulders Access: 21 by 14 inches.
   5. Body Access: 25 by 14 inches.
   6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment. The use of flexible connectors as a means of duct transitions is prohibited.

M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

O. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with draw bands.

Q. Maximum length of flexible branch duct shall not exceed five feet and only be used at air devices.

R. Do not install flexible duct in inaccessible ceilings.

S. Install duct test holes where required for testing and balancing purposes.

T. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00.00

SECTION 23 34 23.00 - 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. Section Includes:
   1. Centrifugal roof ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also 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. Roof curbs.
   7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Roof framing and support members relative to duct penetrations.
   2. Ceiling suspension assembly members.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.8 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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards:
   1. Power ventilators shall comply with UL 705.

1.9 COORDINATION

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

B. Coordinate sizes and locations of roof curbs, equipment supports and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corporation.

2. Breidert Air Products.
3. Greenheck Fan Corporation.
4. Loren Cook Company.

B. Housing: Provide the Following Types of Housing Design:
1. spun-aluminum, dome top and outlet baffle

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

D. Curb Seal: Provide rubber seal between fan and curb to assure proper sealing when attached to curb.

E. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

F. Accessories:
1. Variable-Speed Controller (direct drive fans): Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Provide NEMA 3R, nonfusible type, with thermal-overload protection factory mounted outside fan housing, factory wired through an internal aluminum conduit.
a. For single phase fractional HP fans use a toggle type disconnect switch.
b. For three phase integral HP fans use a NEMA 3R safety switch.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops. Damper motor shall be 120V/1 phase unless otherwise noted. Provide local disconnect switch

G. Roof Curbs: Provide factory fabricated roof curb by the same manufacturer as the equipment. Roof curb to be insulated.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

C. Motors with Variable Frequency Drives: All fan motors shall be of highest efficiency possible, either Premium or High Efficiency rating. All fan motors with VFD’s must be inverter duty rated and fan manufacturer shall factory inverter balance the fan motor through the entire operating range. A/C motors shall be rated for both constant and variable speed applications.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide high static pressure switch in the ductwork downstream of exhaust fans greater than 3 hp. Fan shall shutdown upon detection of static pressure in excess of 2” wc.. Provide manual reset.

B. Install power ventilators level and plumb.

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 33 00 "Air Duct Accessories."

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

C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   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.
5. Adjust damper linkages for proper damper operation.
6. Verify lubrication for bearings and other moving parts.
7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
9. Shut unit down and reconnect automatic temperature-control operators.
10. Remove and replace malfunctioning units and retest as specified above.

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

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

C. Lubricate bearings.

END OF SECTION 23 34 23.00

SECTION 23 37 13.00 – HVAC 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. [**Round ceiling diffusers.**]
2. [**Rectangular and square ceiling diffusers.**]
3. [**Perforated diffusers.**]
4. [**Supply registers and grilles.**]
5. [**Linear bar diffusers.**]
6. [**Linear slot diffusers.**]
7. [**Ceiling-integral continuous diffusers.**]
8. [**Light troffer diffusers.**]
9. [**Round induction diffusers.**]
10. [**Linear floor diffuser plenums.**]
11. [**Drum louvers.**]
12. [**Modular core supply grilles.**]
13. [**Continuous tubular diffusers.**]
14. [**Adjustable bar registers and grilles.**]
15. [**Security registers and grilles.**]
16. [**Fixed face registers and grilles.**]
17. [**Linear bar grilles.**]
18. [**Louvers**]

B. Related Sections:
1. Section 23 05 03 “Submittals for HVAC”.
2. Section 23 07 13 “Duct Insulation”.

1.3 ACTION 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.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. [Round Ceiling Diffuser
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Carnes.
      c. METALAIRE, Inc.
      d. Nailor Industries Inc.
      e. Price Industries.
      f. Titus.
      g. Tuttle & Bailey.
      h. Warren Technologies.
   2. [Devices shall be specifically designed for variable-air-volume flows.]
   3. Material: Steel (Aluminum in wet areas such as locker rooms and shower areas).
   4. Finish: Baked enamel, white.
   5. Face Style: Four cone.
   6. Mounting: Duct connection.
   7. Pattern: Fully adjustable.
   8. Dampers: Butterfly. Not required if equalizing grid is provided.
   9. Accessories:
      a. Equalizing grid.
      b. Plaster ring.
      c. Safety chain.
      d. Wire guard.
      e. Sectorizing baffles.
      f. **Operating rod extension.**]

B. [Rectangular and Square Ceiling Diffusers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Carnes.
      c. Krueger.
      d. METALAIRE, Inc.
      e. Nailor Industries Inc.

f. Price Industries.
g. Titus.
h. Tuttle & Bailey.
i. Warren Technologies.

2. [Devices shall be specifically designed for variable-air-volume flows.]
3. Material: Steel (Aluminum in moist areas such as locker rooms and shower areas).
4. Finish: Baked enamel, white.
5. Face Size: 24 by 24 inches.
6. Face Style: [Three cone][Plaque].
7. Mounting: [Surface][T-bar].
8. Pattern: [Fixed][Adjustable].
9. Dampers: Butterfly in drywall applications. Not required if equalizing grid is provided.
10. Accessories:
a. Equalizing grid.
b. **[Plaster ring.**]]

C. [**Perforated Diffuser:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anemostat Products; a Mestek company.
b. Carnes.
c. Krueger.
d. METALAIRE, Inc.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.
i. Warren Technologies.
2. [Devices shall be specifically designed for variable-air-volume flows.]
3. Material: Steel backpan and pattern controllers, with steel or aluminum face in moist areas such as locker rooms and shower areas.
4. Finish: Baked enamel, white.
5. Face Size: 24 by 12 inches.
6. Duct Inlet: Round or Square.
7. Face Style: Flush.
8. Mounting: Surface or T-bar.
9. Pattern Controller: Fixed with curved blades at inlet or Adjustable with louvered pattern modules at inlet.
10. Dampers: Opposed blade or Butterfly. Not required if equalizing grid is provided.
11. Accessories:
a. Equalizing grid.
b. Plaster ring.
c. Safety chain.
d. Wire guard.
e. Sectorizing baffles.
f. **Operating rod extension.**]

D. [**Supply Registers and Grilles**

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

a. Anemostat Products; a Mestek company.
b. Carnes.
c. METALAIRE, Inc.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.
g. Tuttle & Bailey.
h. Warren Technologies.

2. [Devices shall be specifically designed for variable-air-volume flows.]
3. Material: Steel or Aluminum in moist areas such as locker rooms and shower areas.
4. Finish: Baked enamel, white.
5. Face Size: On Drawings
6. Mounting: Surface or T-bar.
7. Pattern: Adjustable core style.
8. Dampers: Butterfly.
9. Accessories:
a. Square to round neck adaptor.
b. Adjustable pattern vanes.
c. Throw reducing vanes.
d. Equalizing grid.
e. Plaster ring.
f. Safety chain.
g. Wire guard.
h. Sectorizing baffles.
i. **Operating rod extension.**]

2.2 [CEILING LINEAR SLOT OUTLETS

A. [Linear Bar Diffuser

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anemostat Products; a Mestek company.
b. Carnes.
c. Krueger.
d. METALAIRE, Inc.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.

2. [Devices shall be specifically designed for variable-air-volume flows.]
3. Material: Steel or Aluminum in moist areas such as locker rooms and shower areas.
4. Finish: Baked enamel, white.
5. [Narrow Core Spacing Arrangement: 1/8-inch- thick blades spaced 1/4 inch apart, zero or 15-degree deflection.]
6. [Wide Core Spacing Arrangement: 1/8-inch- thick blades spaced 1/2 inch apart, zero or 15-degree deflection.]
7. [Wide Core Spacing Arrangement: 3/16-inch- thick blades spaced 1/2 inch apart, zero or 15-degree deflection.]
8. [Pencil-Proof Core Spacing Arrangement: 3/16-inch- thick blades spaced 7/16 inch apart, zero or 15-degree deflection.]

9. **[One or Two-Way Deflection Vanes: Extruded construction fixed louvers with removable core.]**
10. **Frame: 1-1/4 inches or 1 inch wide.**
11. **[Mounting Frame]**
12. **Mounting: Concealed bracket or Spring clip.**
13. **Damper Type: Adjustable opposed-blade assembly.**
14. **Accessories: Plaster frame.]**

B. [Linear Slot Diffuser

1. **Manufacturers: Subject to compliance with requirements, provide products by one of the following:**
   a. **Anemostat Products; a Mestek company.**
   b. **Carnes.**
   c. **Krueger.**
   d. **METALAIRE, Inc.**
   e. **Nailor Industries Inc.**
   f. **Price Industries.**
   g. **Titus.**
   h. **Tuttle & Bailey.**
   i. **Warren Technologies.**
2. **[Devices shall be specifically designed for variable-air-volume flows.]**
3. **Material - Shell: Steel or Aluminum in moist areas such as locker rooms and shower areas.**
4. **Material - Pattern Controller and Tees: Aluminum.**
5. **Finish - Face and Shell: Baked enamel, black.**
6. **Finish - Pattern Controller: Baked enamel, black.**
7. **Finish - Tees: Baked enamel, white.**
8. **Slot Width: [1”]<other>**
9. **Number of Slots: [2 slot]<other>**
10. **Length: On Drawings**
11. **Insulated plenum boot.**
12. **Accessories: [Plaster frame][T-bar slot].]**

C. [Ceiling-Integral Continuous Diffuser

1. **Manufacturers: Subject to compliance with requirements, provide products by one of the following:**
   a. **Anemostat Products; a Mestek company.**
   b. **Carnes.**
   c. **Krueger.**
   d. **METALAIRE, Inc.**
   e. **Nailor Industries Inc.**
   f. **Price Industries.**
   g. **Titus.**
   h. **Tuttle & Bailey.**
   i. **Warren Technologies.**
2. **Slot Width: [On Drawings]**
3. **Section Length: [On Drawings]**
4. **Straight and curved sections as required to accommodate layout.**
5. **Mitered tees and corners.**
6. **Pattern Controllers: 24 inches o.c.**
7. **Material: Aluminum, extruded, heavy wall.**

8. Finishes:
a. Exterior: Standard white.
b. Interior: Standard black.
9. Throw: Standard or High.
10. Mounting: Ceiling or Sidewall.
11. Plenum: Insulated.
12. Other Features:
a. Painted interior.
b. Blank-offs.]

D. [Light Troffer Diffuser
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anemostat Products; a Mestek company.
b. Carnes.
c. Krueger.
d. METALAIRE, Inc.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.
2. [Devices shall be specifically designed for variable-air-volume flows.]
3. Material: Steel with external insulation.
4. Finish: Black enamel on visible surfaces.
5. Slot Width: On Drawings
6. Length: On Drawings
7. Pattern: Adjustable.
8. Inlet: Top or Side.
9. **Inlet Size: On Drawings]**]

2.3 [UNDERFLOOR AIR DISTRIBUTION DIFFUSERS

A. [Round Induction Diffusers
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anemostat Products; a Mestek company.
b. Carnes.
c. Krueger.
d. METALAIRE, Inc.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
2. Airflow Principle: Swirl-pattern induction.
3. Material: Plastic, high impact, and resistant to cart and foot traffic.
4. Color: Black.
5. Components:
a. Diffuser core.
b. Flow regulator.
c. Dirt and liquid catch pan.
d. Spacer flange.

e. Gasketed, underfloor compression ring.]

B. [Linear Floor Diffuser Plenums

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

a. Anemostat Products; a Mestek company.
b. Carnes.
c. Krueger.
d. METALAIRE, Inc.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.

2. Material: Aluminum.
3. Finish: White baked acrylic.
4. Deflection: [Zero][15] degrees.
5. Components:

a. Aluminum diffuser core.
b. Diffuser frame.
c. **Plenum, 0.034-inch steel.**]]

2.4 [HIGH-CAPACITY DIFFUSERS

A. [Drum Louver

a. Anemostat Products; a Mestek company.
b. Carnes.
c. Krueger.
d. METALAIRE, Inc.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.
i. Warren Technologies.

2. Airflow Principle: Extended distance for high airflow rates.
3. Material: Aluminum, heavy gage extruded.
4. Finish: White baked acrylic.
5. Border: 1-1/4-inch width with countersunk screw holes.
6. Gasket between drum and border.
7. Body: Drum shaped; adjustable vertically.
8. Blades: Individually adjustable horizontally.
9. Mounting: Surface to duct or wall.
10. Inlet Width: [On Drawings]
11. Inlet Length: [On Drawings]
12. Accessories:

a. Opposed-blade steel damper.
b. Duct-mounting collars with countersunk screw holes.]

B. [Modular Core Supply Grilles

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

a. Anemostat Products; a Mestek company.

b. Carnes.
c. Krueger.
d. METALAIRE, Inc.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.
i. Warren Technologies.

2. Throw: Extended distance for airflow rates.
3. Material: Steel.
4. Grilles per Unit: Two.
5. Finish: White baked acrylic.
6. Border: 1-1/2-inch width with countersunk screw holes.
7. Blades:
a. Airfoil, individually adjustable horizontally.
b. Double deflection.
c. Set in modules.
8. Modules: Removable; rotatable.
9. Mounting: Surface.
10. **Accessory: Opposed-blade steel damper.**]]

2.5 [FLEXIBLE DIFFUSION OUTLETS

A. Continuous Tubular Diffuser
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. DuctSox Corp.
b. Patron Products Inc.
2. Material: Flame-retardant, coated polyester and fiberglass fabric.
3. Duct Connection: Round.
4. Duct Connection Size: [On Drawings]
5. Diffusion Hole Size: [On Drawings]
6. Diffusion Hole Frequency - <Number> per 100 Feet: .
7. Accessories:
a. Quick-connect joint.
b. Snap hooks.
c. Cleanout zipper.
d. **Condensate drain.**]

2.6 REGISTERS AND GRILLES

A. [Adjustable Bar Register:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anemostat Products; a Mestek company.
b. Carnes.
c. Krueger.
d. METALAIRE, Inc.
e. Nailor Industries Inc.

f. Price Industries.
g. Titus.
h. Tuttle & Bailey.
i. Warren Technologies.

2. Material: Steel or Aluminum in moist areas such as locker rooms and shower areas.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal or Vertical spaced 3/4 inches apart.
5. Core Construction: Integral.
6. [Rear-Blade Arrangement: Horizontal or Vertical spaced 3/4 inch apart.]
7. Frame: 1-1/4 inches wide.
8. [Mounting Frame: Filter.]
9. Mounting: [Concealed][Lay in].
10. Damper Type: Adjustable opposed blade.
11. Accessories:
a. Front-blade gang operator.
b. **[Filter.]**]

B. [**Adjustable Bar Grille:**
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anemostat Products; a Mestek company.
b. Carnes.
c. Krueger.
d. METALAIRE, Inc.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.
i. Warren Technologies.
2. Material: Steel or Aluminum in moist areas such as locker rooms and shower areas.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal or Vertical spaced 3/4 inches apart.
5. Core Construction: Integral.
6. [Rear-Blade Arrangement: Horizontal or Vertical spaced 3/4 inch apart.]
7. Frame: 1-1/4 inches wide.
8. [Mounting Frame: Filter.]
9. **Mounting: Concealed or Lay in.**]

C. [**Security Register :**
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anemostat Products; a Mestek company.
b. Carnes.
c. Krueger.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.
g. Tuttle & Bailey.
h. Warren Technologies.
2. Security Level: Maximum, Medium, Minimum and suicide deterrent.
3. Application: Ducted return.

4. Material: Steel or Aluminum in moist areas such as locker rooms and shower areas.
5. Material Thickness: 0.19 inch.
6. Finish: Baked enamel, white.
7. Face Arrangement:
a. Shape: Square or Rectangular.
b. Design: Fixed bar or Perforated.
c. Frame: Yes.
d. Deflection: Zero degrees.
e. Core: None.
f. [3/16-inch- thick, front lattice plate with 2-by-2-inch- square holes and 1-inch frets, 0.135-inch wire mesh, and 1/4-inch- thick backer plate.]
g. [3/16-inch- thick, perforated faceplate with 5/16-inch- diameter holes spaced 7/16 inch o.c., staggered at 60 degrees.]
h. [1-1/2-inch bars and mandrel tubes and rods with zero-degree deflection in 1-1/4-by-1-1/4-by-3/16-inch angle border.]
i. [1-3/8-inch bars and double mandrel tubes with zero-degree deflection in 1-3/4-inch angle border.]
8. Damper Operation: Face operated.
9. Damper Type: Adjustable opposed blade.
10. Wall Sleeve: 1/8 inch welded to face Mechanically fastened to border.
11. **Mounting: 1-by-1-by-3/16-inch retaining angle frame.**]

D. [**Security Grille:**
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anemostat Products; a Mestek company.
b. Carnes.
c. Krueger.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.
g. Tuttle & Bailey.
h. Warren Technologies.
2. Security Level: Maximum, Medium, Minimum, and suicide deterrent.
3. Application: Ducted return.
4. Material: Steel or Aluminum.
5. Material Thickness: 0.19 inch.
6. Finish: Baked enamel, white.
7. Face Arrangement:
a. Shape: Square or Rectangular.
b. Design: Fixed bar or Perforated.
c. Frame: Yes.
d. Deflection: Zero degrees.
e. Core: None.
f. [3/16-inch- thick, front lattice plate with 2-by-2-inch- square holes and 1-inch frets, 0.135-inch wire mesh, and 1/4-inch- thick backer plate.]
g. [3/16-inch- thick perforated faceplate with 5/16-inch- diameter holes spaced 7/16 inch o.c., staggered at 60 degrees.]
h. [1-1/2-inch bars and mandrel tubes and rods with zero-degree deflection in 1-1/4-by-1-1/4-by-3/16-inch angle border.]

i. [1-3/8-inch bars and double mandrel tubes with zero-degree deflection in 1-3/4-inch angle border.]

8. Wall Sleeve: 1/8 inch welded to face.

9. **Mounting: 1-by-1-by-3/16-inch retaining angle frame.**]

E. [**Fixed Face Register**

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

a. Anemostat Products; a Mestek company.
b. Carnes.
c. Krueger.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.
g. Tuttle & Bailey.
h. Warren Technologies.

2. Material: Steel or Aluminum in moist areas such as locker rooms and shower areas.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches wide.
7. [Mounting Frame: Filter.]
8. Mounting: Concealed.
9. Damper Type: Adjustable opposed blade.
10. **[Accessory: Filter.]**]

F. [**Fixed Face Grille**

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

a. Anemostat Products; a Mestek company
b. Carnes
c. Krueger
d. Nailor Industries Inc.
e. Price Industries
f. Titus
g. Tuttle & Bailey.
h. Warren Technologies.

2. Material: Steel or Aluminum in moist areas such as locker rooms and shower areas.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches wide.
7. [Mounting Frame: Filter.]
8. Mounting: Concealed.
9. **[Accessory: Filter.]**]

G. [**Linear Bar Grille**

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

a. Anemostat Products; a Mestek company.
b. Carnes.

c. Krueger.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.
g. Tuttle & Bailey.
h. Warren Technologies.

2. Material: Steel or Aluminum in moist areas such as locker rooms and shower areas.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Distribution plenum.
a. Internal insulation.
b. Inlet damper.
6. Frame: 1-1/4 inches wide.
7. [Mounting Frame: Filter.]
8. Mounting: Concealed.
9. **Damper Type: Adjustable opposed blade.**]

2.7 [LOUVERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Airolite Co.
2. Air Balance
3. American Warming & Ventilating, Inc.
4. Arrow United Industries, Inc.
5. Carnes
6. Greenheck
7. Louvers & Dampers, Inc.
8. Penn Ventilator Co., Inc.
9. Ruskin Mfg. Co.
10. Dowco.
11. United Enertech
12. Nailor

B. Performance: Provide louvers that have maximum free area, and minimum pressure drop for each type as listed in manufacturer's current data, complying with louver schedule.

C. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate, which will contain each type of louver.

D. Materials: Construct of aluminum extrusions. Weld units or use stainless steel fasteners.

E. Plenum: Provide insulated plenum on all louvers, same dimension as louver with minimum depth of 12". Provide transition to plenum for proper air distribution. Seal around all plenums to wall to prevent air leakage.

F. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

1. Color: Architect shall select factory painted color of louver from manufacturer's standard range of 20 colors.

G. Provide the following types of Finish for louvers

1. [Anodized Bronze][Aluminum].

2. Finish: Coating to be ACROFLUR, consisting of 50% PVDF (Kynar or Hylar) spray paint. System shall include a 20 year warranty.

H. Provide the following equivalent Model:

1. [Model: Ruskin, Model ELF-375DX]

2. **[Model: Airo-Lite, Brick Vent]**]

2.8 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.

D. [**All return air devices installed opening into a plenum or ceiling space shall be provided with an internally lined 24 gauge sheet metal sound boot, per details, minimum of 24" in length.**]

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 37 13.00

SECTION 23 81 26.00 – VARIABLE REFRIGERANT VOLUME SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Provide heat pump variable refrigerant flow systems

B. Types of indoor system units specified in this section include the following:
   1. Outdoor Condensing Units
   2. Indoor Concealed Ducted Units

C. 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.

D. 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.

E. Related Sections:
   1. Section 23 05 03 “Submittals for HVAC”.

1.3 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.

1.4 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.

1.5 WARRANTY:

A. Warranty on Motor/Compressor: 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. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

B. Warranty Period: 5 years from date of substantial completion.

1.6 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

2.1 MANUFACTURER:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier
   2. Trane Mitsubishi
   3. Daikin

2.2 OUTDOOR CONDENSING UNITS

A. General
   1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator. High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.
   2. The connection ratio of indoor units to outdoor unit shall be permitted up to 130%.
   3. Each outdoor system shall be able to support the connection of up to 56 indoor units dependent on the model of the outdoor unit.
   4. The sound pressure level standard shall be 64 dBA or lower as measured at 3 feet from the front of the unit. The outdoor unit shall be capable of operating automatically at further reduced noise during night time.
   5. The unit shall incorporate an auto-charging feature and a refrigerant charge check function. The unit shall be capable of metering the refrigerant charge. As additional

refrigerant is added to the system, the system shall calculate how much additional refrigerant is required to be added to the system.

6. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.
7. Oil management:
   a. The system shall have high pressure oil return to ensure a consistent film of oil on all moving compressor parts.
   b. The system shall be provided with an oil separator designed to extract oil from the oil/refrigerant gas stream leaving the compressor and return the extracted oil to the compressor oil sump.
   c. Provide an oil level sensor in the compressor to provide direct oil level sensing.
8. The outdoor unit shall be capable at the following operating ambient air conditions:
   a. Cooling: 14°F DB to 122°F DB
   b. Cooling: 4°F DB to 122°F DB with low ambient kit
   c. Heating: -10°F DB to 61°F WB
   d. Cooling based synchronous: 14°F DB to 81°F DB
   e. Heating based synchronous: 14°F DB to 61°F DB

B. Unit Cabinet
1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish.
2. Unit access panels shall be removable with minimal screws and shall provide full acce4ss to the compressor, fan, and control components.
3. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.

C. Fans
1. Outdoor fans shall be direct-drive propeller type, and shall discharge air vertically. Fans shall below air through the outdoor coil.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
4. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
5. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps as shown below.
6.

Operation Sound (dB)	Night Mode Sound Pressure Level (dB)
Step 1 max.	55
Step 2 max.	50
Step 3 max.	45

7.

D. Compressor
1. All compressors shall be inverter driven.
2. The inverter scroll compressors shall be variable speed controlled which is capable of changing the speed to follow the variations in total cooling and heating load as

determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.

3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
5. The capacity control range shall be 4% to 100%.
6. Oil separators shall be standard with the equipment together with an intelligent oil management system
7. Compressor assembly shall be installed on spring or rubber vibration isolators and shall have internal spring isolation.
8. In the event of compressor failure for multiple compressor units, the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.
9. For multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of equalized run time, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

E. Outdoor Coil
1. Coil shall be constructed of aluminum fins mechanically bonded to internally enhanced, seamless copper tubes which are cleaned, dehydrated, and sealed. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance. The heat exchanger on the condensing units shall be manufactured from seamless copper tube with internal grooves mechanically bonded on to aluminum fins to an e-Pass Design. The fins are to be covered with an anti- corrosion acrylic resin and hydrophilic film. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

F. Refrigeration Safeties
1. The following safety devices shall be included on the condensing unit;
    a. High pressure switch.
    b. Control circuit fuses.
    c. Crankcase heaters.
    d. Fusible plug.
    e. High pressure switch.
    f. Overload relay.
    g. Inverter overload protector.
    h. Thermal protectors for compressor and fan motors.
    i. Over current protection for the inverter.
    j. Anti-recycling timers.

G. Electrical Requirements
1. Unit electrical power shall be a single point connection.
2. Unit control voltage to the indoor-fan coil shall be 16 volt DC
3. All power and control wiring must be installed per NEC and all local building codes.
4. High and low voltage terminal block connections.
5. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire.

2.3 INDOOR FAN COIL UNITS

A. CONCEALED CEILING DUCTED UNITS

1. General
   a. Indoor unit shall be a ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation within a conditioned space. It shall have a front discharge air duct collar and filtered back or bottom return air. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature. Included as standard equipment, a long-life filter that is mold resistant and a condensate drain pan. Units 4-tons or less shall be equipped with a condensate pump that pumps to 18" from the drain pipe opening. The indoor units sound pressure shall range from 29 dB(A) to 48 dB(A) at low speed 5 feet below the suction grille.
2. Unit Cabinet
   a. The cabinet shall be located into the ceiling and ducted to the supply and return openings. The exterior of the unit shall be 18 gauge galvanized steel. The interior of the cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
3. Filter
   a. Provide a 2” MERV 13 high efficiency air filter for each medium static unit. For low pressure units, provide a washable long-life filter with mildew proof resin.
4. Fan
   a. The fan shall be direct-drive fan with statically and dynamically balanced impeller with high and low fan speeds available. The airflow rate shall be available in high, medium, and low settings. The fan motor shall be thermally protected.
5. Coil
   a. Coil shall be a minimum 3-row copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. Fin spacing shall no greater than 14 fins per inch. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header. A condensate pump with a 9-13/16” lift shall be located below the coil in the condensate pan with a built in safety alarm.
6. Mixing Box
   a. Provide mixing boxes of physical size to match basic unit, and include equal-sized flanged openings capable of handling full air flow. Arrange openings as indicated on drawing sheets. Provide dual action parallel dampers for return air with sealing edges, arranged to operate automatically with one set of linkage. Provide parallel blade damper for outside air directed towards the return air stream for reduced stratification. Provide dampers of balanced construction, rotating in sintered bronze or nylon bearings.
7. Motors
   a. Motor shall be totally enclosed and permanently lubricated with inherent protection. Fan motor shall be 3-speed.
8. Controls
   a. Controls shall consist of a solid-state electromechanical control system which shall control space temperature and determine optimum fan speed. The temperature control range shall be from 64 F to 84 F. The unit shall have the following functions as a minimum.
   b. Provide hard wired programmable local controller and a return air sensor for each unit.
   c. Controls shall be 24 volt, and shall be easily operated by the user from a wall-mounted control unit.
9. Operating Characteristics

a. The unit shall be matched with an outdoor unit. The combination of the outdoor unit and the indoor fan coil unit shall be sized as scheduled.

10. High Water Alarm
    a. Provide sensor in cooling drain pan that will shut down the indoor unit on high condensate levels.

2.4 CONTROLS

A. Physical Characteristics:
1. General: The control system shall be a neutral color plastic material. Each control may have a Liquid Crystal Display (LCD.

B. Electrical Characteristics:
1. Wiring: Wiring: Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit then to the branch selector box and outdoor unit. Control wiring shall run from the indoor unit terminal block to the specific controller for that unit. The wire shall be a non-shielded, 2-core sheathed vinyl cord or cable, size AWG18-2.

C. Controller Characteristics:
1. Local Remote Controller
    a. The Local Remote Controller shall be mounted into a standard 2” x 4” junction box.
    b. Unit Display
        1) The Local Remote Controller shall be approximately 4.75” x 4.75” in size with a backlit 2.75” x 1.75” LCD display. Display information shall be selectable from English, French, or Spanish.
        2) Provide a backlit LCD display with contrast adjustment and auto off after 30 seconds.
        3) The controller shall display Operation Mode, Setpoint, and Fan Speed. The controller shall display temperature setpoint in one degree increments with a range of 60-90°F. Detailed display will reflect room temperature (60-90°F range in one degree increments). Display of temperature information shall be configurable for Fahrenheit or Celsius.
        4) On/Off status shall be displayed with an LED.
        5) Error codes will be displayed in the event of system abnormality/error with a two digit code.
        6) The following system temperatures can be displayed to assist service personnel in troubleshooting:
            a) Return air temperature
            b) Liquid line temperature
            c) Gas line temperature
            d) Discharge air temperature (if available on the unit)
            e) Remote temperature sensor temperature
            f) Indoor temperature setpoint
2. Operation
    a. The unit shall be capable of controlling a group of up to 16 indoor units. The following operation groups shall be controlled:
        1) On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto* (*with VRV Heat Recovery System))
        2) Independent cooling and heating setpoints in the occupied mode
        3) Independent cooling setup and heating setback
        4) Fan speed
        5) Airflow direction

6) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
7) Lock out key settings
8) Indoor unit group assignment

3. Program Functions
   a. Controller shall support schedule settings with selectable weekly pattern options.
      1) Seven day week
      2) Weekday + weekend
      3) Weekday + Saturday + Sunday
      4) Independently settable cooling and/or heating setpoints when unit is on (occupied).
      5) Setup cooling and heating setback setpoints when unit is off (unoccupied)
      6) A maximum of 5 operations can be schedulable per day
      7) Time setting in 1-minute increments
   b. The Controller shall support auto-changeover mode for both heat pump and heat recovery systems allowing the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat according to the room temperature and temperature setpoint.
      1) Changeover to cooling mode shall occur at cooling setpoint + 1°F.
      2) Changeover to heating mode shall occur at heating setpoint - 1°F.
   c. The Controller shall support an Auto-Off-Timer for temporarily enabling indoor unit operation during the unoccupied period.
      1) When the Off Timer is enabled and when the unit is manually turned on at the remote controller, the controller shall shut off the unit after a set time period.
      2) The time period shall be configurable in the controller menu with a range of 30-180 minutes in 10 minute increments.
   d. The space temperature shall be capable of being sensed at the local controller, the return air temperature sensor mounted in the unit, or a remote temperature sensor.

D. BAS GATEWAY- BACnet or LonTalk
   1. General
      a. The Interface for use in BACnet shall provide the gateway for a Building Automation System (BAS) 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 BAS 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 BAS and shall be accomplished through programming at the BAS 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 Automation System (BAS) and the VRF 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. LED display provides the interface's operational status and alarm.
   b. 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 1^0F (0.1^0C) increments with a range of 60^0F - 90^0F. Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius.
   c. The Interface shall provide the BACnet building management system the capability to display the room temperature in 0.1^0F increments with a range of -120^0F - 180^0F. Display of room temperature information shall be configurable for Fahrenheit or Celsius.
   d. 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 BAS 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 BAS, 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 BAS to force a shutdown of associated indoor unit groups.

PART 3 - EXECUTION

3.1 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.

3.2 INSTALLATION:

A. General: Install units in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Support: Install exterior units on grade on 4" thick concrete pad.

C. 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.

D. 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.

E. 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.

3.3 START UP AND COMMISSIONING

A. The unit manufacturer will be responsible for the start-up, programming, and commissioning of the entire variable refrigerant volume system. This will include coordinating the interface requirements and system points with the temperature controls contractor. Manufacturer shall test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.4 TRAINING OF OWNER'S PERSONNEL:

A. Provide services of manufacturer's technical representative for 1day 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 23 81 26.00

SECTION 23 81 46.00 - WATER-SOURCE UNITARY HEAT PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of water-source heat pumps:
   1. [**Concealed water source heat pumps, 6 tons and smaller.**]

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each model.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which heat pumps will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.

B. Product Certificates: For each type of water-source heat pump, signed by product manufacturer.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water-source heat pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. One set of filters for each unit.

1.7 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water-source heat pumps and are based on the specific system indicated. Refer to Section 016000 "Product Requirements."
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

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. ASHRAE Compliance:
   1. ASHRAE 15.
   2. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Comply with NFPA 70.

F. Comply with safety requirements in UL 484 for assembly of free-delivery water-source heat pumps.

G. Comply with safety requirements in UL 1995 for duct-system connections.

1.8 COORDINATION

A. Coordinate layout and installation of water-source heat pumps and suspension components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components, and partition assemblies.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water-source heat pumps that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, refrigeration components.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 [CONCEALED WATER-SOURCE HEAT PUMPS, 6 TONS AND SMALLER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
1. Carrier Corporation.
2. ClimateMaster, Inc.
3. FHP Manufacturing Inc.
4. Daikin Applied
5. WaterFurnace International, Inc.
6. Aaon.

B. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ARI-ISO-13256-1.

C. Cabinet and Chassis: Galvanized-steel casing with the following features:
1. Access panel for access and maintenance of internal components.
2. Knockouts for electrical and piping connections.
3. Flanged duct connections.
4. Cabinet Insulation: Glass-fiber liner, minimum 1/2 inch thick, complying with UL 181.
5. [Condensate Drainage: Stainless-steel drain pan with condensate drain piping projecting through unit cabinet and complying with ASHRAE 62.1.]
6. [Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.]
7. Sound Attenuation Package:
a. Minimum 0.598-inch- thick compressor enclosure and front panel. Minimum 0.0937-inch- thick foam gasket around the compressor and perimeter of end panel.
b. Sound attenuating blanket over compressor.
c. Hot-gas muffler.

D. Fan: Direct driven, centrifugal, with multispeed motor resiliently mounted in fan inlet.
1. General requirements for motors are specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
2. Motor: Multispeed, permanently lubricated, [ECM] motor.

E. Condensate Pan: Provide IAQ galvanized steel, double sloping drain pain. Provide high condensate in primary condensate pan to de-energize unit upon detection of high condensate levels.

F. Water Circuit:
1. Refrigerant-to-Water Heat Exchangers:
a. [Coaxial heat exchangers with copper water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube leak tested to 450 psig on refrigerant side and 400 psig on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.]
b. [Stainless-steel, brazed-plate heat exchanger leak tested to 450 psig for refrigerant side and 400 psig for water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.]

2. **Water Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.**

G. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig.

H. Refrigerant Circuit Components:
1. **Sealed Refrigerant Circuit: Charge with R-407C or R-410A refrigerant.**
2. **Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.**
3. **Charging Connections: Service fittings on suction and liquid for charging and testing.**
4. **Reversing Valve: Pilot-operated sliding-type valve designed to be fail-safe in heating position with replaceable magnetic coil.**
5. **Compressor: Hermetic scroll compressor installed on vibration isolators and housed in an acoustically treated enclosure with factory-installed safeties as follows:**
   a. **Antirecycle timer.**
   b. **High-pressure cutout.**
   c. **Low-pressure cutout or loss of charge switch.**
   d. **Internal thermal-overload protection.**
   e. **Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below [35 deg F].**
   f. **Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.**
6. **Refrigerant Piping Materials: ASTM B 743 copper tube with wrought-copper fittings and brazed joints.**
7. **Pipe Insulation: Refrigerant minimum 3/8-inch- thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-development indexes according to ASTM E 84.**
8. **Refrigerant Metering Device: Capillary tube or thermal expansion valve to allow specified operation with entering-water temperatures from 25 to 125 deg F.**
9. **[Hot-Gas Reheat Valve: Pilot-operated sliding-type valve with replaceable magnetic coil.]**

I. [Hot-Gas Reheat: Reheat valve diverts refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.]

J. [Filters: Disposable, pleated type, [1 inch] thick and with a minimum of 90 percent arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value of 7 according to ASHRAE 52.2.]

K. Controls:
1. **Basic Unit Controls:**
   a. **Low- and high-voltage protection.**
   b. **Overcurrent protection for compressor and fan motor.**
   c. **Random time delay, three to ten seconds, start on power up.**
   d. **Time delay override for servicing.**
   e. **Control voltage transformer.**
2. **Thermostat:**
   a. **[Wall-Mounted Thermostat:**
      1) **Heat-cool-off switch.**
      2) **Fan on-auto switch.**
      3) **Automatic changeover.**
      4) **[[Concealed] [Exposed] temperature set point.]**

5) [[Concealed] [Exposed] temperature indication.]
6) Deg F indication.]

b. [Wall-Mounted Humidistat: [Concealed] [Exposed].
1) Temperature set point.
2) Temperature indication.]

c. [Wall-mounted temperature sensor.]

d. [Unoccupied period override push button.]

e. LED to indicate fault condition at heat pump.

f. Data entry and access port.
1) Input data include room temperature and humidity set points for occupied and unoccupied periods.
2) Output data include room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

3. Terminal Controller:
a. [Scheduled operation for occupied and unoccupied periods on [7] [365]-day clock with minimum 4 programmable periods per day.]
b. [[Two]-hour unoccupied period override period.]
c. Remote control panel to contain programmable timer and LED for fault condition.
d. Compressor disable relay to stop compressor operation for demand limiting or switch to unoccupied operation.
e. Automatic restart after five minutes if fault clears. Lockout after three attempts to restart following fault. Indicate fault for service technician.
f. Return-air temperature high-limit (firestat). Stop unit on high temperature.
g. Backup for volatile memory.
h. Differential pressure switch to indicate fan status. Fan failure alarm.
i. Differential pressure switch to indicate filter status. Dirty filter alarm.

4. [BAS interface requirements as further described in Section 23 09 00 "Instrumentation and Control for HVAC" and Section 23 09 93 "Sequence and Operations for HVAC Controls."
a. Interface relay for scheduled operation.
b. Interface relay to provide indication of fault at central workstation.
c. Provide [BAC-net] [or] [Lonworks] interface for central BAS workstation for the following functions:
1) Set-point adjustment for set points identified in this Section.
2) Start/stop and operating status of heat-pump unit.
3) Data inquiry to include supply air, room air temperature and humidity, and entering-water temperature.
4) Occupied and unoccupied schedules.]

L. **Electrical Connection: Single electrical connection.**]

2.2 HOSE KITS

A. General: Hose kits shall be designed for minimum 400 psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.

B. Hose: Length 36 inches. Minimum diameter, equal to water-source heat-pump connection size.

C. Isolation Valves: Two-piece bronze-body ball valves with stainless-steel ball and stem and galvanized-steel lever handle. Provide valve for supply and return. If balancing device is combination shutoff type with memory stop, the isolation valve may be omitted on the return.

D. Strainer: Y-type with blowdown valve in supply connection.

E. Balancing Device: Mount in return connection. Include meter ports to allow flow measurement with differential pressure gage.
1. Automatic balancing valve, factory set to operate within 10 percent of design flow rate over a 40:1 differential pressure range of 2 to 80 psig.
2. Manual, calibrated-orifice balancing valve.
3. Manual, venturi-type balancing valve.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of water-source heat pumps.

B. Examine roughing-in for piping and electric installations for water-source heat pumps to verify actual locations of piping connections and electrical conduit before installation.

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

3.2 INSTALLATION

A. [**Equipment Mounting: Install water-source heat pumps with continuous-thread hanger rods and [elastomeric hangers] [spring hangers] [spring hangers with vertical-limit stop] of size required to support weight of water-source heat pump unit.**
1. Comply with requirements for seismic-restraint devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
2. **Comply with requirements for hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."**]

B. Install wall-mounting thermostats, humidistats, and switch controls in electrical outlet boxes at heights to match lighting controls or as required in Section 23 09 00 "Instrumentation and Control for HVAC."

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
1. Connect supply and return hydronic piping to heat pump with unions and shutoff valves or hose kits.
2. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Duct installation requirements are specified in other Sections. Drawings indicate general arrangement of ducts. Specific connection requirements are as follows:
1. Connect supply and return ducts to water-source heat pumps with flexible duct connectors specified in Section 23 33 00 "Air Duct Accessories."

C. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

D. Install piping adjacent to machine to allow service and maintenance.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
1. After installing water-source heat pumps and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, coils, and fans.
3. Inspect internal insulation.
4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Verify bearing lubrication on fan.
9. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
10. Start unit according to manufacturer's written instructions.
11. Complete startup sheets and attach copy with Contractor's startup report.
12. Inspect and record performance of interlocks and protective devices; verify sequences.
13. Operate unit for an initial period as recommended or required by manufacturer.
14. Verify thermostat [**and humidistat**]calibration.
15. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
16. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
17. Start refrigeration system and measure and record the following:
    a. Coil leaving-air, dry- and wet-bulb temperatures.

b. Coil entering-air, dry- and wet-bulb temperatures.
c. Outdoor-air, dry-bulb temperature.
d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

18. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.7 CLEANING

A. Replace filters used during construction prior to air balance or substantial completion.

B. After completing installation of exposed, factory-finished water-source heat pumps, inspect exposed finishes and repair damaged finishes.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water-source heat pumps. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 81 46.00

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DIVISION 26 - ELECTRICAL

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

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SECTION 260501 - GENERAL PROVISIONS - ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special, and Supplementary Conditions, and Divisions 00 and 01 Specification Sections, apply to this Section.

B. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

C. Each Contractor shall be governed by any alternates, unit prices and Addenda or other contract documents insofar as they may affect his part of the work.

1.2 SUMMARY

A. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of complete and operating Electrical Systems indicated on the drawings and/or specified herein.

B. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Electrical Systems in a substantial manner, in compliance with the requirements stated, implied, or intended in the drawings and specifications, shall be included as part of this Contract. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

C. It is not the intent of this Section of the Specifications to make any Contractor, other than the General Contractor, Prime Contractor, Construction Manager responsible to the Owner. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the General Contractor to the Architect, then to the Engineer. Also, this Section of the Specifications shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be optional.

D. This section of the Specifications or the arrangement of the Contract Documents shall not be construed as an attempt to arbitrarily assign responsibility for work, material, equipment or services to a particular trade Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the Prime Contract.

E. It is the intent of this Contract to deliver to the Owners a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials to be installed by other trades without additional cost to the Owner.

F. In general, and to the extent possible, all work shall be accomplished without interruption of the existing facilities' operations. Each Contractor shall advise the Architect, Owner and Engineer in writing at least one week prior to the deliberate interruption of any services. The Owners shall be advised of the exact time that interruption will occur and the length of time the interruption will occur. Failure to comply with

this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed. Contractor will not be entitled to additional compensation due to work stoppage mandated by unscheduled interruption.

G. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work. The Contractor shall abide by the requirements of the Special Conditions and the Owner's outage request program.

H. Required Notices: Ten days prior to the submission of a proposal, each proposer shall give written notice to the Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, Proposers signify that they have included the cost of all required items in the proposal and that the Proposer will be responsible for the safe and satisfactory operation of the entire system.

I. Any reference within these specifications to a specific entity, i.e., "Electrical Contractor" is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.

J. In each of the specifications and drawings referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.3 DEFINITIONS AND ABBREVIATIONS

A. Prime Contractor - The Contractor who has been engaged by the Owner in a contractual relationship to accomplish the work.

B. Contractor - Any Contractor whether bidding, proposing or working independently or under the supervision of a General Contractor, Prime Contractor, Construction Manager and who installs any type of Electrical Work as specified in the Contract Documents.

C. Electrical Contractor - Any Contractor whether bidding or working independently or under the supervision of a General Contractor, that is: the one holding the Prime Contract and who installs any type of Electrical work, such as: power, lighting, television, telecommunications, data, fiber optic, intercom, fire detection and alarm, security, video, underground or overhead electrical, etc.

D. Electrical Sub-Contractor - Each or any Contractor contracted to, or employed by, the Electrical Contractor for any work required by the Electrical Contractor.

E. Engineer - The Consulting Mechanical-Electrical Engineer either consulting to the Owner, Architect, or Other, etc. In this case: CMTA, Inc., Consulting Engineers.

F. Architect - The Architect of Record for the project.

G. Contract Documents - All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Manager's Assignments, Architect's Supplemental Instructions, Construction Contract with Owner, etc.

H. Bidder/Proposer - Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.

I. The Project - All of the work required under this Contract.

J. Furnish - Deliver to the site in good condition and turn over to the Contractor who is to install.

K. Provide - Furnish and install complete, tested and ready for operation.

L. Install - Install equipment furnished by others in complete working order.

M. Indicated - Listed in the Specifications, shown on the Plans or Addenda thereto.

N. Basis of Design (BOD): Documentation of primary thought processes and assumptions behind design decisions made to meet design intent. Describes systems, components, conditions and methods chosen to meet intent.

O. Monitoring: Recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or trending capabilities of control systems.

P. Start-up: The activities where systems or equipment are initially tested and operated. Start-up is completed prior to functional testing.

Q. Vendor: Supplier of equipment.

R. Typical or Typ- Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.

S. ADA - Americans with Disabilities Act.

T. ANSI - American National Standards Institute.

U. ASA – American Standards Association.

V. ASTM – American Society for Testing Materials.

W. ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers.

X. BAS – Building Automation System.

Y. BICSI – Building Industry Consulting Services International

Z. CM – Construction Manager

AA. EE – Electrical Contractor

BB. FCC – United States Federal Communications Commission

CC. GC – General Contractor

DD. IECC – International Energy Conservation Code

EE. IEEE – Institute of Electrical and Electronics Engineers.

FF. ISO – International Standards Organization.

GG. KBC - Kentucky Building Code.

HH. NEC – National Electrical Code (NFPA 70).

II. NECA – Standards for Installation.

JJ. NEMA - National Electrical Manufacturers Association.

KK. NESC – National Electrical Safety Code.

LL. NFPA - National Fire Protection Association.

MM. OSHA - Office of Safety and Health Administration.

NN. TIA – Telecommunications Industry Association

OO. RFI – Request for Information

PP. RIO – Rough-in Only

QQ. UL - Underwriters Laboratories, Inc.

RR. UON – Unless otherwise noted.

1.4 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

1.5 INTENT AND INTERPRETATION

A. It is the intent of these specifications and all associated drawings that the Contractor provide finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete, tested and ready for operation."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

C. It is the intention of the Contract Documents to call for a complete and operational system, including all components, accessories, finish work, etc. as necessary for trouble free operation; tested and ready for operation. Anything that may be required, implied, or inferred by the Contract Documents shall be provided and included as part of the Bid.

D. All Contractors and Vendors providing a bid for this project shall review the Plans and Specifications and determine any modifications and/or adjustments necessary relative to the proposed equipment and materials with specific manufacturer’s installation requirements. Include in the bid any necessary installation methods, features, options, accessories, etc. necessary to install the proposed equipment and materials, regardless of whether used as basis of design or being offered as a substitution in accordance with the specific manufacturer’s installation requirements whether specifically detailed or not within the Plans and Specifications.

E. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

F. The Bidder/Proposer shall completely review the Contract Documents. Any interpretation as to design intent or scope shall be provided by the Engineer / Architect. Should an interpretation be required, the Bidder/Proposer shall request a clarification not less than ten (10) days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event of any conflict, discrepancy, or inconsistency develops; the interpretation of the Engineer shall be final.

G. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten (10) days prior to bid. In the absence of such written notice and by the act of submitting a bid, it shall be understood that the Contractor has included the cost of all required items in the bid, and that will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

1.6 ELECTRICAL DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted in writing to the Engineer for approval before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Contractors shall, however, anticipate that additional offsets may be required and submit their bid accordingly.

B. The drawings and specifications are intended to supplement each other. No Contractor, bidder, proposer or supplier shall take advantage of conflict between them, or between parts of either, but should this condition exist, the Contractor or supplier shall request a clarification of the condition at least ten days prior to the submission of bids so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

C. The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. This Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make minor adjustments in location of conduit, fixtures, outlets, switches, etc., where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance.

F. Each Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

G. Should overlap of work between the various trades become evident, this shall be called to the attention of the Engineer. In such an event, neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

H. The Electrical drawings are intended to show the approximate location of equipment, materials, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions whether given in figures or scaled shall be verified in the field. In case of conflict between small and large scale drawings, the larger scale drawings shall take precedence.

I. The Electrical Contractor and his Sub-Contractors shall review all drawings in detail as they may relate to his work (structural, architectural, site survey, mechanical, etc.). Review all drawings for general coordination of work, responsibilities, ceiling clearances, wall penetration points, chase access, fixture elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineers at least ten (10) days prior to bids, for issuance of clarification by written addendum.

J. Where on any of the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornament or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

K. Special Note: Always check ceiling heights indicated on Drawings and Schedules and ensure that these heights may be maintained after all mechanical and electrical equipment is installed. If a conflict is apparent, notify the Engineer in writing for instructions.

1.7 EXAMINATION OF SITE AND CONDITIONS

A. Each Contractor shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. All Contractors shall carefully examine all Drawings and Specifications and inform themselves of the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of his work.

B. Each Contractor shall fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of temporary or permanent utilities, etc. The Contractor shall include in his work all expenses or disbursements in connection with such matters and conditions. Each Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer ten (10) days prior to bid, any apparent omissions or discrepancies in order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

C. The Electrical Contractor is required to provide coordination drawings, data and collaboration for all aspects of his work in accordance with the general and special conditions – Divisions 20, 21, 22, 23, 25, 26, 27 and 28 and the Construction Manager's procedures.

1.8 EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

A. When any Contractor requests review of substitute materials and/or equipment, and when under an approved formal alternate proposal, it shall be understood and agreed that such substitution, if approved, will be made without additional cost regardless of changes in connections, spacing, service, mounting, etc. In all cases where substitutions affect other trades, the Contractor offering such substitutions shall advise all such Contractors of the change and shall reimburse them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Special Note: Review of Shop Drawings by the Engineer does not absolve the Contractor of this responsibility.

B. References in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. Each Contractor, in such cases, may, at his option, use any article, device, product, material, fixture, form, or type of construction which in the judgment of the Engineer is equivalent to that specified, provided the provisions of Paragraph 5.1 immediately preceding are met. Substitutions shall be submitted to the Engineer a minimum of ten (10) days prior to bid date for approval to bid in written form through addenda or other method selected by the Engineer. If prevailing laws of cities, towns, states or countries are more stringent than these specifications regarding such substitutions, then those laws shall prevail over these requirements.

C. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the engineers.

D. Each Contractor shall furnish along with his proposal a list of specified equipment and materials which he proposes to provide. Where several makes are mentioned in the Specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall have the right to choose any of the makes mentioned without change in price.

1.9 SINGLE SOURCE RESPONSIBILITY AND OBSOLETE EQUIPMENT

A. Except where specifically noted otherwise, all equipment supplied by the Contractor shall be the standard products of a single manufacturer of known reputation and experience in the industry. Only equipment, components and accessories in current production for at least five (5) years beyond the completion date of this system shall be used and installed. Any equipment found to be obsolete or not in future production will be removed and replaced at Contractor's expense. This includes all equipment, materials and labor.

1.10 CODES, RULES, PERMITS, FEES, REGULATIONS, ETC.

A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, and other costs including utility connections or extensions, in connection with his work. As necessary, he shall file all required plans, utility easement requests and drawings, survey information on line locations, load calculations, etc., prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

B. Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.

C. The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus or drawings required in order to comply with all applicable laws, ordinances rules and regulations, whether or not shown on drawings and/or specified.

D. All materials furnished and all work installed shall comply with the current edition of the National Electrical Codes, National Fire Codes of the National Fire Protection Association, the requirements of local utility companies, and with the requirements of all governmental agencies or departments having jurisdiction.

E. All material and equipment for the electrical systems shall bear the approval label, or shall be listed by the Underwriters' Laboratories, Incorporated. Listings by other testing agencies may be acceptable with written approval by the Engineer.

F. All electrical work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Fire Marshal, as applicable or required. Electrical work shall not commence until such plans are in the hands of the Electrical Contractor.

G. The Contractor shall ensure that his work is accomplished in accord with OSHA Standards and any other applicable government requirements.

H. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

1.11 SUPERVISION OF WORK

A. Each Contractor and Sub-Contractors shall personally supervise the work or have a competent superintendent on the project site at all times during progress of the work, with full authority to act for him in matters related to the project.

1.12 COST BREAKDOWNS AND PAY APPLICATION

A. Within thirty days after acceptance of the Contract, each Contractor is required to furnish to the Engineer one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made on forms provided or approved by the Engineer or Architect. Payments will not be made until satisfactory cost breakdowns are submitted. Refer to Division 0 and 1 specification sections for additional requirements.

B. In addition to cost breakdowns by specification section, the following shall also be provided: Material and labor shall be listed separately. These items are in addition to items listed in front-end specifications. Pay special attention to required withholding percentages for startup, testing, documentation, acceptance, owner training, etc. The breakdown shall be minimally as follows:

1. Permitting
2. Mobilization
3. Electrical Shop Drawings/Submittals
4. Electrical Coordination Drawings
5. Temporary Power
6. Interior Lighting Materials & Labor
7. Exterior Lighting Materials & Labor
8. Lighting Controls Materials & Labor

9. Electrical Distribution (Switchgear) Materials & Labor
10. Feeders Materials & Labor
11. Branch Circuiting Materials & Labor
12. Service Grounding Materials & Labor
13. Electrical Devices Materials & Labor
14. Fire Alarm Materials & Labor
15. Fire Alarm System Startup, Testing, & Verification (shall equal 5% of Equipment Value)
16. Electrical Distribution Equipment Startup, Testing, & Verification (shall equal 2.5% of Equipment Value)
17. Lighting and Lighting Controls Startup, Testing, & Verification (shall equal 2.5% of Equipment Value)
18. Low Voltage Systems Startup, Testing, & Verification (shall equal 5% of Equipment Value)
19. Emergency Engine Generator Standby Systems Startup, Testing, & Verification (shall equal 2.5% of Equipment Value)
20. Owner Training & Acceptance
21. Punchlist
22. As-Built/Record Drawings & Acceptance
23. O&M Manuals & Acceptance
24. Warranty
25. Demobilization

1.13 GUARANTEES AND WARRANTIES

A. Each Contractor shall unconditionally guarantee all equipment, apparatus, materials, and workmanship entering into this Contract to be the best of its respective kind and shall replace all parts at his own expense, which fail or are deemed defective within one year from final acceptance of the work by the Engineer. The effective date of completion of the work shall be the date each or any portion of the work is accepted by the Engineer and Owner’s Statement of Substantial Completion.

B. Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer, such as generators, engines, batteries, transformers, etc., shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate the guarantee except that the Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

C. The Warranties specified in this and other Articles shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. All light fixtures shall have a five (5) year unconditional warranty (Parts, Labor and Travel)

E. All generators shall have a five (5) year unconditional warranty (Parts, Labor and Travel)

F. Provide all warranty certificates to Owner. All warranties begin starting at the substantial completion date, submit warranty certificates accordingly.

1.14 INSPECTION, APPROVALS AND TESTS

A. Before requesting a final review of the installation from the Architect and/or Engineer, the Contractor shall thoroughly inspect his installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineers for unnecessary and undue work on their part.

B. Owner's and Engineer's inspections: Two (2) inspections will be held to generate and then review punchlist items. All site inspections and visits thereafter shall be billed to the Contractor at the Engineer's standard hourly rates.

C. The Contractor shall provide as a part of this contract electrical inspection by a competent Electrical Inspection Agency, licensed to provide such services. The name of this agency shall be included in the list of materials of the Form of Proposal by the Contractor. All costs incidental to the provision of electrical inspections shall be borne by the Electrical Contractor.

D. The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when he anticipates commencing work. Failure of the Inspection Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

E. Inspections shall be scheduled for rough as well as finished work. The rough inspections shall be divided into as many inspections as may be necessary to cover all roughing-in without fail. Report of each such inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.

F. Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.

G. Before final acceptance, the Contractor shall furnish three (3) copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one (1) copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

H. The Contractor shall test all wiring and connections for continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by Megger Test the insulation resistance of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, pull out the defective conductor, replacing same with new and demonstrate by further test the elimination of such defect.

1.15 COORDINATION DRAWINGS

A. Detailed electronic coordination drawings shall be required for this project. A specific line-item shall be included on the schedule of values by each Trade for “preparation of coordination drawings”. This line-item value shall be approved by the Engineer. The Engineer and the Engineer’s Field Inspector shall closely monitor progress and quality of the preparation of the electronic coordination drawings and may withhold pay requests as deemed appropriate.

B. Coordination Drawings shall be provided on this project by each Trade (Mechanical, Fire Protection, Electrical). Drawings shall be 30x42 sheet size and shall be at ¼” scale and shall match the drawing setup as included in the Architectural Drawings. Drawings shall be prepared in electronic format utilizing AutoCad software. The Architect and Engineer will supply electronic drawings files of the Contract Documents upon the Contractor’s request and release.

C. The basis for the Coordination Drawings shall be the sheet metal ductwork fabrication shop drawings, all electrical feeder conduits and other conduits 2” and larger, and pneumatic tube system piping and components in ceiling spaces. The Coordination Drawings shall be prepared by the Mechanical Contractor. The Coordination Drawings shall indicate (1) systems above ceilings in finished areas, (2) systems supported from the structure in finished areas without ceilings, (3) systems in the mechanical rooms, and (4) all wall, roof, floor penetrations. These drawings shall indicate all ductwork as double lined with bottom elevations noted.

D. The sheet metal fabrication shop drawings shall be completed in a timely manner so as not to conflict with construction schedule and phasing plan. At the Construction Manager’s discretion, these drawings shall be completed in phases to correspond with the project construction work sequencing. The Mechanical Contractor shall furnish an electronic copy of these ductwork shop drawings to all other

Trades, specifically the Fire Protection and Electrical and other Contractors as requested by the Construction Manager for the purpose of including other trades work on the Coordination Drawings.

E. Pre-Coordination Meetings with all necessary trades shall occur. During these meetings, the Contractors shall discuss locations/elevations where piping, conduits, cable path, etc. will be installed with respect to the sheet metal fabrication drawings and other trades. The sheet metal ductwork and gravity piping systems shall be given the first priority. Within 30 days of the meeting, each Trade shall provide the Mechanical Contractor electronic drawings of all of their systems (with elevation noted), coordinated with the ductwork and other trades for them to incorporate into the Coordination Drawings. Coordination Meetings shall then occur so that all conflicts can be resolved between Trades. All conflicts shall be resolved between all Trades at these Coordination Meetings and the Mechanical Contractor shall then amend the Drawings to include the Final Coordinated Work.

F. It is realized that not all systems can be completely detailed. The coordination drawings shall include the following at a minimum:

1. All supply/return/exhaust ductwork.
2. All above slab sanitary and roof drainage piping.
3. HVAC, fire protection and domestic water piping which are 2” in size and greater, excluding insulation.
4. Electrical conduits which are 1.5” in size and greater.
5. J-hook and cable tray cabling paths
6. Multiple smaller piping/conduits hung on a common hanger.
7. All wall, roof, floor penetrations.
8. Light fixtures.

G. After completion of the Final Coordination Drawings, a Final Review with the all Trades shall occur to provide any final comments and approval by all Trades. Other interim coordination meeting will be required to ensure successful coordination drawings. Any additional coordination items will be updated by the Mechanical Contractor. The Final Approved Coordination Drawings shall be distributed electronically (on CD) to each Trade by the Mechanical Contractor. The Mechanical Contractor shall also furnish a complete 30x42 paper set of drawings to the jobsite main office and shall utilize them for updates of field conditions/deviations that occur during construction. Final Approved Coordination Drawings shall also be distributed to the Construction Manager, Owner, Architect and Engineer for their Records. This process shall be completed prior to starting any work.

H. Each Contractor shall ensure that any deviations from the Coordination Drawings are recorded as they occur, in red erasable pencil on record drawings kept at the jobsite. Upon completion of a particular phase, the Mechanical Contractor shall incorporate all field deviations into the Coordination Drawings to be utilized as Record Drawings. The Engineer shall review the Record Documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. The Record Drawings shall be distributed electronically (on CD) to the Construction Manager, Owner, Architect and Engineer for their Records.

I. The Mechanical Contractor is responsible to the General Contractor for the shop drawing layout of the following rooms and details:

1. Concrete pads and foundations
2. Equipment room layouts with actual equipment
3. Roof layouts
4. Trench locations and sizes
5. Dimensioned floor drain locations
6. Congested areas above ceilings adjacent to mechanical and electrical rooms
7. Dimensioned ductwork shop drawings

8. Refer to Part 43 for additional requirements.

J. The Electrical Contractor is responsible to the General Contractor for the shop drawing layout of the following rooms and details:

1. Concrete pads and foundations
2. Equipment room layouts with actual equipment
3. Routes of feeder conduits and all other conduits 1.5" and larger
4. J-hook and cable tray cabling paths
5. Congested areas above ceilings adjacent to mechanical and electrical rooms
6. Refer to Part 41 for additional requirements.
7. Light fixture locations
8. Exact layouts of all work in open ceiling areas

1.16 SURVEYS, MEASUREMENTS AND GRADES

A. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, he shall notify the Engineer thru normal channels of job communication and shall not proceed with his work until he has received instructions from the Engineer.

1.17 UTILITY COMPANY REQUIREMENTS

A. The Contractor shall provide the local utility company with a drawing produced by a licensed Land Surveyor or a licensed Engineer in the State of Kentucky and acceptable to the utility that locates the centerline of the primary duct. Coordinate further requirements with utility company.

B. Contact the utility company for specifics on construction of pads, conduit, etc., prior to bidding the work and determine all their requirements. All work shall be in accordance with their standards.

C. The electrical contractor is responsible for all fees, permit costs, etc., from the electrical utility, data, telephone and cable TV companies. This includes any cost associated with the underground electrical service extension.

D. Each contractor, prior to bidding the work, is to contact the utility companies (electric, data, telephone and cable TV) and determine the exact points of extension of all underground services in the field with a representative of each utility company. Also, obtain construction details on manholes, transformer pads, pedestal stub-ups, etc., from each utility company as applicable. Extension points indicated on the plans are approximate, and are given for the bidder's information only.

1.18 TEMPORARY SERVICES

A. The Contractor shall arrange for temporary electrical and other services which he may require to accomplish his work. In the absence of other provisions in the contract, the Contractor shall provide for his own temporary services of all types, including the cost of connections, utility company fees, construction, removal, etc., in his bid.

B. All temporary services shall be removed by Contractor prior to acceptance of work.

1.19 TEMPORARY USE OF EQUIPMENT

A. The permanent electrical equipment, (except lighting), when installed, may be used for temporary services, subject to an agreement among the Contractors involved, the Owner, and with the consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all

temporary connections required and any replacements required due to damage without cost, leaving the equipment and installation in "as new" condition. The Contractor may be required to bear utility costs, user fees, etc.

B. Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

1.20 MATERIALS AND WORKMANSHIP

A. All electrical equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. All workmanship shall be first-class and shall be performed by electricians skilled and regularly employed in their respective trades. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).

B. All conduit and/or conductors shall be concealed in or below walls, below floors or above ceilings, unless otherwise noted. All fixtures, devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein. Raceways shall not be placed within foundation walls and footings.

C. All materials, where applicable, shall bear Underwriters' Laboratories label or that of another Engineer approved testing agency, where such a standard has been established.

D. Each length of conduit, wireway, duct, conductor, cable, fitting, fixture and device used in the electrical systems shall be stamped or indelibly marked with the maker’s mark or name.

E. All electrical equipment shall bear the manufacturer's name and address and shall indicate its electrical capacity and characteristics.

F. All electrical materials, equipment and appliances shall conform to the latest standards of the National Electric Manufacturers Association (NEMA) and the National Board of Fire Underwriters (NBFU) and shall be approved by the Owner's insuring agency if so required.

G. Comply with National Electrical Contractors Association (NECA) performance standards that are published as National Electrical Installation Standards (NEIS).

H. All applicable equipment and devices provided shall meet all FCC requirements and restrictions.

1.21 QUALIFICATIONS OF WORKMEN

A. All electrical contractors bidding this project must have been a licensed company for a minimum of three (3) years to qualify to bid this project. Individual employee experience does not supersede this requirement.

B. All subcontractors bidding the electrical work must have completed one project of 70% this subcontract cost size and two projects of 50% this subcontract cost size.

C. All electrical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workmen shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.

D. All electrical work shall be accomplished by Journeymen electricians under the direct supervision of a licensed Electrician. All applicable codes, utility company regulations, laws and permitting authority of the locality shall be fully complied with by the Contractor.

E. Special electrical systems, such as Fire Detection and Alarm Systems, Telecommunications or Data Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by workmen normally engaged or employed in these respective trades.

1.22 CONDUCT OF WORKMEN

A. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden.

1.23 COOPERATION AND COORDINATION BETWEEN TRADES

A. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Mechanical, Structural and other pertinent Drawings, to the end that complete coordination between trades will be affected.

B. Refer to Coordination Among Trades, Systems Interfacing and Connection of Equipment Furnished by Others section of these Specifications for further coordination requirements. The Contractor is responsible for the correct location of all rough-in and connections at every piece of equipment. Work not correctly located shall be relocated at the Contractor's expense.

C. Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than ¼" = 1'-0", clearly indicating how his work is to be installed in relation to the work of other trades, or so as not to cause any interference with work of other trades. He shall make the necessary changes in his work to correct the condition without extra charge.

D. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.24 PROTECTION OF EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All rough-in conduit shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged while stored on site either before or after installation shall be repaired or replaced (as determined by the Engineer) by the responsible Contractor. Electrical equipment exposed to the weather shall be replaced by the Contractor at his expense.

1.25 SCAFFOLDING, RIGGING AND HOISTING

A. The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

1.26 CONCRETE WORK

A. The Contractor shall be responsible for the provision of all concrete work required for the installation of any of his systems or equipment. If this work is provided by another trade, it will not relieve the Electrical Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Electrical work shall be 3000 PSI minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication ACI-318. Heavy equipment shall not be set on pads for at least seven days after pour.

B. All concrete pads shall be complete with all pipe sleeves, embeds, anchor bolts, reinforcing steel, concrete, etc., as required. Pads larger than l8" in width shall be reinforced with minimum #4 round bars on 6" centers both ways. All reinforcing steel shall be per ASTM requirements, tied properly, lapped 18 bar diameters and supported appropriately up off form, slab or underlayment. Bars shall be approximately 3" above the bottom of the pad with a minimum 2" cover. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms properly adhered repairs shall be made. If structural integrity is violated, the concrete shall be replaced. All surfaces shall be rubbed to a smooth finish.

C. Special Note: All pads and concrete lighting standard bases shall be crowned slightly so as to avoid water ponding beneath equipment.

D. In general, concrete pads for small equipment shall extend 6" beyond the equipment's base dimensions. For large equipment with service access panels, extend pads l8" beyond base or overall dimensions to allow walking and servicing space at locations requiring service access.

E. Exterior concrete pads shall be 4" minimum above grade and 4" below grade on a tamped 4" dense grade rock base unless otherwise noted or required by utility company. Surfaces of all foundations and bases shall have a smooth finish with three-quarter inch radius or chamfer on exposed edges, troweled or rubbed smooth. All exterior pads shall be crowned approximately 1/8" per foot, sloping from center for drainage.

1.27 SMOKE AND FIRE PROOFING

A. The Contractor shall not penetrate rated fire walls, ceilings or floors with conduit, cable, bus duct, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the rating of the assembly. Smoke and fire stop all openings made in walls, chases, ceiling and floors. Patch all openings around conduit, wireway, bus duct, etc., with appropriate type material to smoke stop walls and provide needed fire rating at fire walls, ceilings and floors. Smoke and fire proofing materials and method of application shall be approved by the local authority having jurisdiction. Refer to architectural plans and specifications for further requirements.

B. Contractor to provide heat detectors in the area of construction with complete fire detection until fire alarm system is operational and construction is complete.

C. Fire-stopping materials and installation shall be by a single source through-out the project, by all trades.

D. All fire-stopping assemblies must be UL listed. Provide shop drawings indicating penetration detail for each type of wall and floor construction. Shop drawings must be specific for each individual type (i.e., one-hour fire rated gypsum wall board with insulated metal pipe penetration.) and must indicate a UL listing for the complete fire-stopping assembly.

E. 3M fire protection products are listed below. Equivalent products may be submitted if they are UL listed.

F. All of the fire-stopping shall be applied by a Contractor who is certified by the manufacturer of the fire-stopping product for installation of the product.

G. Fire-stopping materials to include but not limited to the following:

1. 3M fire barrier FS-195 wrap/strip.
2. 3M fire barrier CP 25 caulk.
3. 3M fire barrier MP moldable putty.
4. 3M fire barrier RC-1 restricting collar with steel hose clamp.
5. 3M fire barrier damming materials.
6. 3M fire barrier CS-195 composite sheet.
7. 3M fire barrier fire dam 150 caulk.
8. Steel sleeves.
9. Hilti Speed Sleeves.

1.28 QUIET OPERATION, SUPPORTS, VIBRATION AND OSCILLATION

A. All work shall operate under all conditions of load without any objectionable sound or vibration, the performance of which shall be determined by the Engineer. Noise from moving machinery or vibration noticeable outside of room in which it is installed, or annoyingly noticeable noise or vibration inside such room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor (or Contractors responsible) at his expense.

B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc., by means of flexible connectors, vibration absorbers or other approved means. Surface mounted equipment such as panels, switches, etc., shall be affixed tightly to their mounting surface.

C. The Contractor shall provide supports for all equipment furnished by him using an approved vibration isolating type as needed. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. No work shall depend on the supports or work of unrelated trades unless specifically authorized in writing by the Architect or Engineer.

1.29 WELDING

A. The Contractor shall be responsible for quality of welding done by his organization and shall repair or replace any work not done in accordance with the Architect's or structural Engineer's specifications for such work. If required by the Engineer, the responsible Contractor shall cut at least three welds during the job for X-raying and testing. These welds are to be selected at random and shall be tested as a part of the responsible Contractor's work. Certification of these tests and X-rays shall be submitted, in triplicate, to the Engineer. In case a faulty weld is discovered, the Contractor shall be required to furnish additional tests and corrective measures until satisfactory results are obtained.

1.30 ACCESSIBILITY

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of his work. He shall cooperate with the General Contractor (or Construction Manager) and all other Contractors whose work is in the same space, and shall advise each Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.

B. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.

C. Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Architect's standards for such work. In the absence of such specifications, at a minimum such work shall comply with the specifications below. All locations for access panels which are not specifically indicated on the drawings shall be submitted to and approved by the architect prior to ordering.

D. Access Doors; in Ceilings or Walls:

1. In mechanical, electrical and service spaces: 14-gauge aluminum brushed satin finish, 1" border.
2. In finished areas: 14-gauge primed steel with 1" border to accept the architectural finishes specified for the space. Confirm these provisions with the Architect prior to obtaining materials or installing any such work.
3. In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.

1.31 RESTORATION OF NEW OR EXISTING SHRUBS, PAVING, ETC.

A. The Contractor shall replace to their original condition all paving, curbing surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations. Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item to be replaced. All repairs shall be to the satisfaction of the Engineer, and in accord with the Architect's standards for such work, as applicable. Patchwork on new construction will not be accepted.

1.32 MAINTENANCE OF EXISTING UTILITIES AND LINES

A. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that come within the contract construction site, shall be subject to continuous uninterrupted maintenance with no exception unless the Owner of the utilities grants permission to interrupt same temporarily, if need be. Provide one week's written notice to Engineer, Architect and Owner prior to interrupting any utility service or line. Also see Paragraph 1.2 - SUMMARY, of this specification.

B. Known utilities and lines as available to the Engineer are shown on the drawings. However, it is additionally required that, prior to any excavation being performed, each Contractor ascertain and mark all utilities or lines that would be endangered by the excavation. Contractor shall bear costs of repairing damaged utilities.

C. If the above mentioned utilities or lines occur in the earth within the construction site, the Contractor shall first probe and make every effort to locate the lines prior to excavating in the respective area.

D. Cutting into existing utilities and services shall be done in coordination with and as designated by the Owner of the utility. The Contractor shall work continuously to restore service(s) upon deliberate or accidental interruption, providing premium time and materials as needed without extra claim to the Owner.

E. The Contractor shall repair to the satisfaction of the Engineer any surface or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.

F. Machine excavation shall not be permitted within ten feet of existing gas or fuel lines. Hand excavate only in these areas, in accord with utility company, agency or other applicable laws, standards or regulations.

G. Protect all new or existing lines from damage by traffic, etc. during construction.

H. Protect existing trees, indicated to remain with fencing or other approved method. Hold all new subsurface lines outside the drip line of trees, offsetting as necessary to protect root structures. Refer to planting or landscaping plans, or in their absence, consult with the Architect.

1.33 MANUFACTURER'S NAMEPLATE

A. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.34 ELECTRICAL CONNECTIONS

A. The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring through starters. The Contractor shall install all starters not factory mounted on equipment. Unless otherwise noted, the supplier of equipment shall furnish starters with the equipment. Also, refer to Division 20, 21, 22, 23, 24, 25, 26, 27, and 28 of Specifications, shop drawings and equipment schedules for additional information and requirements.

B. All control, interlock, sensor, thermocouple and other wiring required for equipment operation shall be provided by the Contractor. All such installations shall be fully compliant with all requirements of Division 26, 27 and 28 regardless of which trade actually installs such wiring. Motors and equipment shall be provided for current and voltage characteristics as indicated or required. All wiring shall be enclosed in raceways unless otherwise noted.

C. Each Contractor or Sub-Contractor, prior to bidding the work, shall coordinate power, control, sensor, interlock and all other wiring requirements for equipment or motors with all other contractors or sub-contractors, to ensure all needed wiring is provided in the Contract. Failure to make such coordination shall not be justification for claims of extra cost or a time extension to the Contract.

1.35 FINAL CONNECTIONS TO EQUIPMENT

A. The roughing-in and final connections to all electrically operated equipment furnished under this and all other sections of the contract documents or by others, shall be included in the Contract and shall consist of furnishing all labor and materials for connection. The Contractor shall carefully coordinate with equipment suppliers, manufacturer's representatives, the vendor or other trades to provide complete electrical and dimensional interface to all such equipment (kitchen, hoods, mechanical equipment, panels, refrigeration equipment, etc.).

1.36 ENERGIZED EQUIPMENT

A. At no time shall the contractor work on energized electrical equipment. Contractor shall comply with NFPA 70E requirements at all times throughout construction.

1.37 MOTORS

A. Each motor shall be provided by the equipment supplier, installer or manufacturer with conduit terminal box and NEC required disconnecting means as indicated or required. Three-phase motors shall be provided with external thermal overload protection in their starter units. Single-phase motors shall be provided with thermal overload protection, integral to their windings or external, in control unit. All motors shall be installed with NEMA-rated starters as specified and shall be connected per the National Electrical Code.

B. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower as applicable. Motors producing excessive noise or vibration shall be replaced by the responsible contractor. Refer to Division 20, 21, 22, 23 and 25 of the Specifications for further requirements and scheduled sizes.

C. All three-phase motors shall be tested for proper rotation. Correct wiring if needed and retest. Document testing and corrective action in operations and maintenance manual.

1.38 CUTTING AND PATCHING

A. Unless otherwise indicated or specified, the Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

B. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

1.39 SLEEVES AND PLATES

A. Each Contractor shall provide and locate all sleeves and inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where sleeves and inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

B. Sleeves shall be provided for all electrical conduit passing thru concrete floor slabs and concrete, masonry, tile and gypsum wall construction. Sleeves shall not be provided for piping running embedded in concrete or insulating concrete slabs on grade, unless otherwise noted.

C. Where sleeves are placed in exterior walls below grade, the space between the pipe or conduit and the sleeves shall be packed with oakum and lead, mechanical water stop or other approved material and made completely water tight by a method approved by the Engineer and/or Architect.

D. Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following:

1. Terminate sleeves flush with walls, partitions and ceiling.
2. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
3. In all areas where pipes are exposed, extend sleeves 1/2 inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor.

E. Sleeves shall be constructed of 24-gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings.

F. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction occurs around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction. Fire and smoke stop all sleeves in a manner approved by the local authority having jurisdiction or per prevailing codes.

1.40 ANCHORS

A. Each Contractor shall provide and locate all inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

1.41 CONDUIT MOUNTING HEIGHTS

A. All exposed or concealed conduit, raceways, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed conduit shall, insofar as possible, run perpendicular or parallel to the building structure.

1.42 PAINTING

A. Each fixture device, panel, junction box, etc., that is located in a finished area shall be provided with finish of color and type as selected or approved by the Architect or Engineer. If custom color is required, it shall be provided at no additional cost to the Owner. All other equipment, fixtures or devices located in finished or unfinished areas, that are not required to have or are provided with finish color or coating shall be provided in a prime painted condition, ready to receive finish paint or coating. All galvanized metal in finished areas shall be properly prepared with special processes to receive finish paint as directed and approved by the Architect.

1.43 WEATHERPROOFING

A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

1.44 EQUIPMENT/CONTROLS STARTUP & VERIFICATION

A. A pre-start-up conference shall be held with the Engineer, Owner, Construction Manager, General Contractor, Mechanical Contractor, Electrical Contractor, Controls Contractor, Test and Balance Contractor, and any manufacturer’s providing startup services. The purpose of this meeting will be to discuss the goals, procedures, etc. for start-up

B. Equipment and controls startup and verification shall be required for this project. A specific line-item shall be included on the schedule of values by each Trade for "equipment and controls startup". This line-item value shall be approved by the Engineer. The Engineer, Owner and the Engineer's Field Inspectors shall closely monitor progress and quality of the equipment and controls startup and may withhold pay requests as deemed appropriate.

C. The Contractor shall include in the bid to provide equipment and controls startup and verification for ALL Electrical systems specified for this project. Specific startup/verification specifications are included throughout the Electrical specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians (not third party contractors) and shall complete and submit start-up reports/checklists. Submit factory start-up reports to the Engineer. The contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner.

D. Many pieces of equipment and systems are specified with "manufacturer" startup. In general, the manufacturer's recommended startup procedures and checklists will be acceptable for use in the project. Where "manufacturer" startup is not specified, then this Contractor shall perform startup services in strict accordance with manufacturer's instructions. All startup/verification process shall be thoroughly documented by the Contractor and shall include the time and date when performed.

E. The Contractor shall be responsible for completion of their own System Verification Checklist (SVC) / Manufacturer's Checklists. Furnish to the Testing Agent and Engineer. Sample checklists shall be submitted to the Engineer, Owner, and Testing Agent for approval.

1.45 OPERATING INSTRUCTIONS

A. Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating his systems and equipment for a period of three days of eight hours each, or as otherwise specified. During this period, instruct the Owner or his representative fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least one week's written notice to the Owner, Architect and Engineer in advance of this period. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

B. Unless specified otherwise in Division 1, each Contractor shall furnish three (3) complete bound sets for approval to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions.

C. Unless specified otherwise in Division 1, each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

1.46 CLEANING

A. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish caused by his operations; and at the completion of the work, shall remove all rubbish, all of his tools, equipment, temporary work and surplus materials, from and about the premises, and shall leave the work clean and ready for use. If the Contractor does not attend to such cleaning immediately upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the responsible Contractor. Each Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.

B. After completion of all work and before final acceptance of the work, each Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels,

stickers, etc., from the exterior of materials, equipment and all associated fabrication. Pay particular attention to finished area surfaces such as lighting fixture lenses, lamps, reflectors, panels, etc.

1.47 INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

1.48 HAZARDOUS MATERIALS

A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of their work, insure that their workers are aware of this potential and what they are to do in the event of suspicion. The Contractor shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

C. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

D. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

E. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

1.49 ABOVE-CEILING AND FINAL PUNCH LISTS

A. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project.

1. For review of in-wall work that will be concealed by drywall or other materials well before substantial completion.
2. For review of the above-ceiling work that will be concealed by tile or other materials well before substantial completion.
3. For review of all other work as the project nears substantial completion.

B. When all work from the Contractor’s punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the

Engineer develop a punch list. This request is to be made in writing two weeks prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list and all work prior to the ceilings being installed and at the final punch list review.

C. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review.

D. At the engineer's option, the contractor shall supply digital photographs via email or file-share of any installed work.

E. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money order (due 10 days from date of each additional visit) at a rate of $125.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.

F. All panelboard fronts shall be omitted until final punch list inspection is made. Directories for each panelboard shall be completed and available for review by the Engineer at that time.

1.50 POSTED OPERATING INSTRUCTIONS

A. Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
3. Safety precautions.
4. The procedure in the event of equipment failure.
5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

B. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.51 TRAINING AND RELATED SUBMITTALS

A. Upon completion of all work and all tests, Contractor shall provide classroom and in the field training for each type and/or model of equipment installed. Training shall be led by qualified factory certified technician. Contractor shall submit a request to schedule training sessions a minimum of two weeks in advance. Submission shall include qualifications of instructor as well as a syllabus that the Owner will add/deduct to as they see fit. Each individual listed as an "Attendee" on the roster submitted by the Owner shall receive a copy of the maintenance manual to review during training. All training sessions shall be recorded and a DVD with proper labels identifying the date, equipment, and project shall be delivered prior to Completion of the project. If the audio from the recording is unclear, narration shall be added. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

B. The training phase shall be accompanied by complete as-built documentation and the technical systems operation manual.

C. These training sessions shall be videotaped by the Installer and copies provided to the Owner within one (1) week of training

D. Brochures: Furnish Owner a complete set of operating instructions and diagrams.

E. Systems/Components which require owner training. The training shall be accomplished by a factory trained representative. Include (8) hours minimum for each system described here-in. Each equipment representative shall be represented wherever their equipment is used. All training shall be videotaped by the Installer. The following systems shall include owner training at a minimum:

1. Lighting control system
2. Electrical Distribution (Switchgear)
3. Electrical Devices
4. Fire Alarm Materials & Labor
5. Access Controls
6. Security

F. Instruction Program: Submit outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

G. At completion of training, submit two complete training manual(s) for Owner's use.

H. Qualification Data: For facilitator, instructor and photographer.

I. Attendance Record: For each training module, submit list of participants and length of instruction time.

J. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

K. Demonstration and Training DVDs: Submit two copies within seven days of end of each training module.

L. Identification: On each copy, provide an applied label with the following information:

1. Name of Project.
2. Name and address of photographer.
3. Name of Architect and Construction Manager.
4. Name of Contractor.
5. Date video was recorded.
6. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

M. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video. Include name of Project and date of video on each page.

1.52 EQUIPMENT/SYSTEMS TESTING, VERIFICATION & START-UP

A. The Contractor (and Sub-Contractors) shall be responsible for commissioning, starting-up, testing, checking, examining, inspecting, etc. their own systems.

B. The Electrical Contractor shall designate an individual under his employment to lead the start-up, testing and verification process. This person should not be the project manager or job site superintendent, but a person dedicated to making this critical task successful and completed in a timely manner.

C. This individual shall also be responsible for the following items:

1. All identification and labeling requirements per plans and specifications.
2. Submission of switchgear coordination study, fault current study, and arc flash hazard analysis.

D. A pre-start-up conference shall be held with the Architect, Owner, Construction Manager, Electrical Contractor, and the Manufacturers providing startup services. The purpose of this meeting will be discuss the goals, procedures, etc. for start-up.

E. A specific line-item shall be included on the schedule of values for testing and verification of all systems indicated in this section. This line-item value shall be approved by the Engineer. The Engineer, Owner

and the Engineer's Field Inspector(s) shall closely monitor progress and quality of the testing, verification, and startup and may withhold pay requests as deemed appropriate.

F. The Contractor shall test all wiring and connections for continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by Megger Test the insulation resistance of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, pull out the defective conductor, replacing same with new and demonstrate by further test the elimination of such defect.

G. Systems Requiring Testing & Verification:

1. Fire Alarm System
2. Electrical Distribution Equipment
3. Lighting and Lighting Controls
4. Emergency Standby Systems
5. All Low Voltage Systems
6. Grounding Systems
7. Wiring and Terminations

H. The Contractor shall include in the bid to provide systems startup and verification for ALL electrical systems specified for this project. Specific startup, testing, and verification specifications are included throughout the Electrical specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians (not third party Contractors) and shall complete and submit start-up reports/checklists. Submit start-up reports to the Engineer. The Contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner. Where factory start-up is not specified for a particular piece of equipment or system, the Contractor shall be responsible to perform start-up.

I. The Contractor shall be responsible for completion of System Verification Checklist (SVC) / Manufacturer's Checklists. Furnish to the Testing Agent and Engineer. Sample checklists shall be submitted to the Engineer, Owner, and Testing Agent for approval.

J. The completed reports shall be organized and bound together in a tabbed binder and submitted for review and approval.

1.53 SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, emergency generators, alarm pull boxes and panels, etc. At least two (2) of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

1.54 CLOSEOUT DOCUMENTS

A. All items listed in this section shall be provided to the engineer upon substantial completion. Provide three bound copies with complete index and tabs to locate each item.

B. As-Built Record Drawings:

1. The Contractor shall insure that any deviations from the design are being recorded daily, as necessary, on record drawings being maintained by the Contractor. Dimensions from fixed, visible permanent lines or landmarks shown in vertical and horizontal ways shall be utilized. Compliance shall be a requirement for final payment. Pay particular attention to the location of underfloor or underground exterior in-contract or utility-owned or leased service lines, main switches and other appurtenances important to the maintenance and safety of the Electrical System. Deliver these record drawings to the Engineer as a system is completed, within ten days

of the mark-up and/or while the accuracy of the mark-ups can be verified visually. Monthly payment may be withheld if the requirement is not complied with.

2. All underground utilities/piping installed as part of this project shall be surveyed by a land surveyor licensed in the State of Kentucky. This shall include underground electrical primary, communications, vaults. The survey shall include actual duct bank depths to top of conduit every 100 feet in length. The survey shall also include benchmarks dimensions relative to above grade, fixed structures. The survey shall be furnished on a compact disc in AutoCad ".dwg" format and ".pdf" format. Provide a GPS coordinate of each geothermal well and indicate on the as-built drawing. The survey information shall be included in the closeout documentation.
3. Refer to additional record drawing requirements within the general conditions and other sections of these specifications.

C. Start-up and System Testing Certifications and Reports:

1. Provide reports from all required testing to indicate procedures followed and complete results of all tests. Provide reports on manufacturer's standard forms for all equipment and system tests. Testing shall be per applicable NEC, NFPA, UL, NETA, and/or ANSI standards.

D. Operation and Maintenance Manuals

1. Upon substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three (3) complete bound hard copies and a digital copy of operation and maintenance instructions and parts lists for all equipment provided in this contract. Formatting and content shall follow the guidelines outlined in the latest version of ASHRAE Application Handbook, Guideline 4. As a minimum, the following shall be included:
2. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions.
3. Each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.
4. The operation and maintenance document directory should provide easy access and be well organized and clearly identified.
5. The operation and maintenance manuals shall contain the following information:

    a. Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
    b. Provide contacts (company name, address, phone number, email) where parts may be purchased for all equipment.
    c. Provide detailed maintenance instructions, including recommended preventative maintenance schedules for all equipment requiring maintenance. For lighting and lighting controls, provide recommended re-lamping program, provide a schedule for inspecting and recalibrating lighting controls, and provide a recommended settings list for all components with adjustable settings.
    d. General Information. Provide the following:

        1) Building function
        2) Building description
        3) Operating standards and logs

    e. Technical Information. Provide the following:

        1) System description
        2) Operating routines and procedures
        3) Seasonal start-up and shutdown
        4) Special procedures
        5) Basic troubleshooting

    f. The maintenance manual should contain the following information:

1) Equipment data sheets. Provide the following:
   a) Operating and nameplate data
   b) Warranty
   c) Detailed operating instructions.

2) Maintenance program information. Provide the following:
   a) Manufacturer's installation, operation, and maintenance instructions
   b) Spare parts information
   c) Preventive maintenance actions
   d) Schedule of actions
   e) Action description
   f) History

g. Test reports document observed performance during start-up and commissioning.
h. Reference Division 1 specifications for additional requirements.

E. Shop drawings will not be accepted as satisfying the requirement for Operation and Maintenance Manuals.

F. Shop Drawings: Provide complete copies of all approved shop drawings. Where shop drawings were returned "Furnish as Corrected", the contractor shall make the corrections noted by the engineer and submit final corrected shop drawings with close-out documentation.

G. Parts Lists: Provide an inventory of all spare parts, special tools, attic stock, etc. that have been provided to the owner.

H. Warranties: Contractor's one-year warranty and all other specific warranties indicated in the construction documents.

I. Training Verification: Provide certification that all specified training has been completed. List training session dates, times, and types.

J. Inspection Certificates: Provide certificates of inspection from electrical inspector, fire marshal, and any other required special inspections.

K. Panel Schedules: Provide hard copies and digital copies of Excel files for all panel-board schedules.

L. Final Power System Study Reports.

M. Fire Alarm System Certification.

N. Power Riser Diagram: Provide a framed full-size copy of the overall power riser diagram (under glass) to the Owner. Also, provide three (3) vinyl-coated copies of same. Where an existing power riser diagram is present, the Contractor shall obtain the document from the Owner, and update in digital format with the scope of this project. Edits shall be in digital format and this work shall be closely coordinated with the Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION (260501)

DIVISION 26 - ELECTRICAL

SECTION 260502 - SCOPE OF THE ELECTRICAL WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SCOPE OF THE ELECTRICAL WORK

The Electrical work for this project includes all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, verify place in service and deliver to the Owner complete electrical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not limited to the following:

1. All raceways, conduits, cable management systems, cable trays, J-hooks, conductors, outlet boxes, fittings, pull boxes, manholes, etc.
2. All low-voltage distribution equipment, switchboards, panelboards, disconnect switches, company switches, fuses, transformers, contactors, starters, etc.
3. Electrical Studies including Fault Current, Arc Flash, and Coordination Studies. All studies to be performed by manufacturer of electrical distribution equipment.
4. Electrical Contractor shall install, mount and wire VFD’s which shall be furnished by the Mechanical Contractor, unless otherwise noted.
5. All wiring devices and device plates.
6. Cable splicing, terminations, supports, etc.
7. All light fixtures, drivers, ballasts and lamps.
8. Electrical connection to all electrically operated equipment furnished and/or installed by others, including powered casework, athletic equipment, mechanical equipment, gym equipment, theater equipment, kitchen equipment, etc.
9. Grounding, per NEC and specified requirements.
10. Identification of electrical systems and equipment labeling.
11. All low-voltage systems as listed in System Responsibilities Matrix on Electrical Legend.
12. Pathways and raceways for Voice/Data system shall be provided by Division 26 Contractor in accordance with Division 26 and 27 Specifications. All other Division 27 infrastructure shall be provided by the Division 27 Contractor.
13. Fire alarm system in accordance with Division 28 Specifications.
14. Video system, including antennas, cabling, electronics, terminal plates, service conductors, etc.
15. Security system, complete with equipment, detectors, wiring, etc.
16. Cabling, testing and devices for data/voice network.
17. All necessary coordination with the Owner, electric utility company, telephone company, cable television company, etc. to ensure that work, connections, etc., that they are to provide is accomplished and that service to this facility is delivered complete prior to occupancy.
18. Paying all necessary fees and costs for inspections of all Division 26, 27 and 28 systems by a Licensed Electrical Inspector.

19. Paying all necessary fees and cost for permits, electrical inspections, work by utility companies (power, telephone, cable television company, etc.). The Contractor shall contact the utility companies prior to submitting a bid to determine exactly these charges will be.
20. Prior to submitting a bid, the Contractor shall contact all serving utility companies and municipal services to determine exactly what each utility company will provide and exactly what is required of the Contractor and the Contractor shall include all such requirements in his base bid. This shall include relocation fees and construction cost recovery due to Power Utility Company and Cable Company or their successors.
21. All general and special conditions required to accomplish the work.
22. Special Note: A specialty sub-contractor (Electronic Systems Contractor) shall be utilized for all video, paging-intercom system, data/voice network, fire alarm work, sound systems and for the security system installation. The sub-contractor shall be especially skilled in such work and shall be able to demonstrate that their regular business involves such installations. The specialty sub-contractor(s) shall be acceptable to and approved by the Owner. The names of each such sub-contractor shall be listed on the form of proposal at the time of opening bids. Provisions for branch circuits, pulling of cabling, and installation of raceways for specialty systems may be regular sub-contractor if approved by specialty contractor. All terminations, connections, check-out and testing shall be by specialty contractor.
23. Prior to commencing any work, contractor shall provide this Engineer and the Owner with a pre-certification of the entire fire alarm, security, video surveillance, AI-phone, video, sound, and intercom systems. This test shall be in writing and shall be performed immediately after receipt of notice to proceed. No work is to commence until owner is in possession of certification. The Owner will then instruct on how to proceed with connections of any found problems. Failure of the contractor to perform this work in a timely fashion will not result in a change or time extension to the project. The data/voice system will be assumed without problems and the contractor shall be responsible for any problems found during or after construction.

1.3 SPECIAL REQUIREMENTS

1. Electrical Switchgear (Switchboards), Transformers, and Panelboards shall be installed complete, finished and functional by September 30, 2024.

1.4 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

END OF SECTION

DIVISION 26 - ELECTRICAL

SECTION 260503 - SHOP DRAWINGS, SUBMITTALS, LITERATURE, MANUALS, PARTS LISTS, AND SPECIAL TOOLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, one (1) set of shop drawings and/or manufacturer’s descriptive literature on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer’s descriptive literature shall have proper notation indicated on it and shall be clearly referenced so the specifications, schedules, light fixture numbers, panel names and numbers, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer’s attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term “as specified” will not be accepted.

B. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

D. The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. Shop Drawings: Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

G. Product Data: Submittal shall include performance and characteristic curves.

1.3 SUBMITTALS AND SHOP DRAWING

A. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:

1. Power Equipment

   a. Fault Current, Arc Flash and Coordination studies (submit along with switchgear & panelboards).
   b. Switchgear, switchboards, distribution panelboards and panelboards.
   c. Circuit breakers and fusible switches, per each type.
   d. Dry-type transformers.
   e. Meter bases and CT cabinets.
   f. Power and lighting contactors.
   g. Disconnect switches.
   h. Fuses, per each type required.
   i. Control components (relays, timers, selector switches, pilots, etc.)
   j. Metering devices.
   k. Transient voltage surge suppression devices (SPD’s)
   l. Complete grounding system.

2. Raceways

   a. Conduits and each type of conduit fittings.
   b. Surface-mounted metal or plastic raceways, with each type of fitting.
   c. Wireways and each type of wireway fitting.
   d. J-hook assembly.
   e. Composite pullboxes.

3. Conductors

   a. Conductors, splicing devices, and connectors, each by type.
   b. Splice or tap blocks.

4. Devices

   a. Each type of wiring device and their coverplates.
   b. Floor boxes and poke-thrus, each by type, with required accessories.
   c. Data/voice/video wallplates, each by type.
   d. Any special items not listed above.

5. Lighting

   a. Light fixtures, each by type, marked to indicate all required accessories and lamp selection. Also provide original color selection chart to allow Architect and/or Engineer to indicate color selection.
   b. Lamps, each by type.
   c. Ballast and drivers, each by type.
   d. Lighting standards or poles.
   e. Photocells, time clocks or other lighting accessories.

f. Lighting control system schematic, functional & programming data, along with building specific floor plan drawings indicating each device, master controller, input device locations and specific interconnect/wiring requirements for each device.

6. Fire alarm system.

a. Note: Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Include system specific wiring schematics showing each device and its specific interconnect/wiring requirements. For rack mounted equipment, provide a scalable elevation drawing with proposed component locations & specific interconnect wiring requirements for each component/panel. Also provide scale building specific layout drawings that indicate device placement, wiring, etc. Refer to the specific system's specification for additional submittal requirements where required.

7. Grounding

a. Electrodes, bonding devices, terminals, etc.
b. Building service grounding electrode components.

8. Electronic 3D Coordination Drawings per Electrical General Provisions

9. Dimensioned electrical room plans/equipment layouts

10. Fire-stopping

11. Seismic Restraints

12. Miscellaneous

a. Control panel assemblies.
b. Non-standard junction/pullboxes.
c. Manholes, hand holes, and all outdoor electrical equipment and fittings.
d. Floor plan and riser drawings that show the location of all fire alarm devices.
e. Floor plan and riser drawings that show the location of all low-voltage systems.

13. Systems

a. Note: Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Also, provide scale building layout drawings that indicate device placement, wiring, etc. Drawings shall be in digital format and shall include complete (not typical) riser diagrams of all systems. Refer to specific system's specification for additional submittal requirements where required.
b. Fire alarm system
c. Security systems(s)
d. Video surveillance system
e. All other systems as listed on Systems Responsibility Matrix - See Electrical Legend.

14. Special wrenches, tools and keys

1.4 FIRE ALARM SHOP DRAWINGS

A. The Contractor and equipment supplier shall submit to the Architect and/or Engineer, fire alarm system shop drawings complete with catalog cuts, descriptive literature and complete system wiring diagrams for their review prior to the Contractor’s submittal to the Commonwealth's Department of Housing, Buildings and Construction or other governing authority for their review. No work shall be done until drawings are approved by the Kentucky Department of Housing, Buildings and Construction.

B. Fire alarm drawings shall be created in digital format (CAD or equivalent). Drawings shall include all power supply, battery, and circuit load and voltage drop calculations as required by NFPA. Complete wiring diagrams and proposed device addresses shall be provided.

C. Shop drawings shall indicate all devices as required to satisfy all local and state mandates, whether indicated on construction drawings or not. Include all components as required for a complete and operational system.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION – Not Used

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260504 - SLEEVING, CUTTING, PATCHING AND REPAIRING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 SUMMARY

A. The Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the Construction Manager, General Contractor and all other trades. He shall determine and coordinate any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the responsible Contractor.

B. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Architect. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.

C. The Contractor shall cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.

D. The Contractor shall notify other trades in due time where he will require openings of chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.

E. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

F. Where any cutting, coring, etc. of reinforced concrete is required, such structures shall be x-rayed to avoid damaging existing reinforcing steel.

G. Where sleeves are placed in exterior walls below grade, the space between the pipe or conduit and the sleeves shall be made completely water tight. Provide Crouse-Hinds Link-Seal Environmental Conduit Seal with stainless steel hardware. Alternative methods shall be approved by the Engineer and/or Architect during shop drawing review.

H. In all cases, sleeves shall be at least two pipe sizes larger than nominal pipe diameter.

I. All roof penetrations shall be made inside mechanical equipment curbs, UON.

J. Sleeves passing through roof or exterior wall or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed.

K. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.

L. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Architect and Structural Engineer.

M. The Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Architect.

N. All work improperly done or not done at all as required by the Electrical trades in this section will be performed by the Contractor at the direction of the trade whose work is affected. The cost of this work shall be paid for by the Contractor who is in non-compliance with the Contract.

O. All penetrations shall be patched with materials matching that which has been disturbed.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, hot-dipped galvanized, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness: Shall be 0.138 inch (10 gauge).

2.2 GROUT

A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. The Contractor shall provide and locate all sleeves and inserts required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for conduits where sleeves and inserts were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the conduit and the sleeves shall be made completely and permanently water tight.

D. Conduits that penetrate fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.

E. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.

F. Sleeves in floors shall extend 4" above finished floor level.

G. Escutcheon plates shall be provided for all conduits passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the conduit. Where plates are provided for conduits passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the conduit sleeves.

H. In all areas where busducts are exposed and pass thru floors, the opening shall be surrounded by a 4-inch-high by 3-inch-wide concrete curb.

I. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

3.2 CUTTING

A. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Engineer.

B. Conduit openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

C. X-ray concrete slabs and walls prior to core drilling. Do not core drill through rebar, steel or reinforcing material without written permission from the Structural Engineer and Architect.

D. Openings in metal building walls shall be made in strict accord with building suppliers recommendations.

3.3 PATCHING AND REPAIRING

A. Patching and repairing made necessary by work performed under this division shall be included as a part of the work and shall be done by skilled mechanics of the trade or trades for work cut or damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the Engineer.

B. Where portions of existing lawns, shrubs, paving, etc. are disturbed for installation of work of this Division, such items shall be repaired and/or replaced to the satisfaction of the Engineer.

C. Where the installation of conduit, raceways, etc. requires the penetration of fire or smoke rated walls, ceilings or floors, the space around such conduit, raceways, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.

D. Conduits passing through floors, ceilings and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the conduit around which it is installed.

E. Stainless steel collars shall be provided around all conduits, raceways, etc., at all wall penetrations; both sides where exposed.

F. Where conduits pass through interior or exterior walls, the wall openings shall be sealed air tight. This shall include sealing on both sides of the wall to ensure air does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260506 – DEMOLITION, RESTORATION AND SALVAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This section includes electrical demolition, patching, disposal and salvaging requirements.

B. This Section includes all labor, material, equipment and services necessary and incidental to complete all the demolition and removal of electrical work as shown on the Drawings or as required.

C. The demolition drawings do not necessarily indicate all the conditions, details, or work required. The Contractor shall examine the building to determine the actual conditions and extent of the work. Any details not clear to this Contractor shall be referred to the Architect/Engineer for clarification prior to bidding.

D. The Contractor shall be responsible for demolition and removal of all existing electrical systems where shown for demolition. No portion of electrical systems shown for demolition may be abandoned in place.

1.3 DESCRIPTION OF WORK

A. This section covers all demolition, restoration and salvage required to perform the electrical work indicted on the drawings, specified and/or as required to complete the project. It is the intent of this section of work to remove all existing electrical equipment, materials, etc. which are not required for the completed building and to restore any and all finished surfaces to their original type and conditions. To accomplish these requirements, the Contractor(s) shall, at his own expense, engage the services of others already performing finish work on this project. All work shall be completed to the satisfaction of the Architect/Engineers whose decisions shall be final. This requirement shall apply to all restoration work whether indicated or specified.

B. Electrical Contractor shall re-pull new wire/cable to all devices and equipment that have been cut-off from a panelboard or electronics due to demolition work. Contractor shall check/test all devices and verify they are functional.

C. All adjacent areas need to remain in operation and services to other areas need to be maintained during demolition.

D. Schedule all demolition and any outages affecting other areas with owner.

E. Provide and maintain temporary partitions and/or dust barrier per Owner’s dust control plan.

1.4 SCHEDULING

A. Schedule work to coincide with new construction.

B. Cease operations immediately when structure appears to be in danger and notify Architect. Do not resume operations until directed.

1.5 QUALITY ASSURANCE

A. Comply with NFPA, NEC and OSHA requirements.

B. Contractor shall verify the extent of the demolition work. Any questions as to which systems are to be removed versus which systems are to remain shall be referred to the Architect/Engineer for clarification prior to commencing demolition work.

C. The demolition work shall be a phased operation and shall comply with the construction sequence schedule. The Contractor shall submit a schedule of demolition work 14 days prior to the start of work. The Contractor shall not proceed with the work until receiving written approval.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate electrical system demolition with other systems being demolished.

1.7 SITE SURVEY

A. Before submitting bid, bidder shall carefully examine existing field conditions, including the main power and power distribution system. Claims for extra labor, equipment and materials required due to existing conditions, which could have been foreseen, will not be recognized.

1.8 ELECTRICAL

A. Where electrical fixtures, equipment or other materials are removed and/or relocated, all abandoned conduit and conductors shall be removed in exposed areas. In concealed areas, materials shall be abandoned in place or removed as indicated and patch all openings. Contractor shall remove all conduit, wire, connections, etc. for electrical items being demolished. Contractor shall maintain continuity of existing circuits where removed items do not represent the complete circuit and devices. Field verify exact requirements.

B. The Contractor shall be responsible for the removal and/or relocation of any electrical equipment, fixtures, devices, appurtenances, etc. which may, in the course of construction, interfere with the installation of any new and/or relocated Architectural, Mechanical, Electrical, Structural or Fire Protection Systems whether indicated or not.

C. Relocate junction boxes and provide low-voltage raceways and supports for existing cabling in areas above new inaccessible ceilings.

D. Where components of any system in this Contractor’s scope of work are to be reused, the contractor shall test those components prior to removal and record the state of functionality and condition of the components as tested. These records shall be provided to the owner or engineer upon request. In the absence of these records, all components removed shall be assumed functional at the time of removal. Any device subsequently found to be non-functioning or in unsuitable condition for reuse shall be replaced at the expense of the contractor.

1.9 REPAIR

A. Unless otherwise indicated, the Contractor shall be responsible for the patching and repairing of all holes, etc. in the ceiling, wall and floors where electrical equipment is removed. Patching shall be accomplished with similar materials to the existing ceilings, walls and floors and shall match adjacent surfaces.

1.10 COORDINATION

A. Conduct demolition to minimize interference with adjacent and occupied building areas.

B. Coordinating and sequence demolition so as not to cause shutdown of operation of surrounding areas.

C. Coordinate demolition of all affected electrical systems to prevent disruption to the Owner and minimize downtime.

D. Coordinate demolition by other Divisions of the Specifications to prevent disruption to the Owner and minimize the downtime.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify wiring and equipment indicated to be demolished serve only abandoned facilities.

B. Verify termination points for demolished services.

C. Verify field measurements and circuiting arrangements are as shown on Drawings.

D. Verify that abandoned wiring and equipment serve only abandoned facilities.

E. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Architect/Engineer before disturbing existing installation.

F. Beginning of demolition means installer accepts existing conditions.

3.2 DOCUMENTATION

A. Contractor is responsible for submitting photos and documenting existing conditions to Owner prior to commencing demolition. Systems and equipment found to be defective after demolition has commenced shall be repaired or replaced by Contractor at no additional cost to Owner.

3.3 PREPARATION

A. Erect, and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Owner, Contractor's employees, and existing improvements to remain.

B. All existing computer equipment racks and open or closed raceways must be covered before start of Work.

C. Use temporary egress signage and emergency lighting as needed.

D. Thoroughly examine, review and document all existing infrastructure conditions to determine use. Submit plan to Owner detailing all planned modifications to existing conditions and new work. Owner shall provide written approval to Contractor before proceeding with work.

E. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

F. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

3.4 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Remove demolished material from Project site, except as indicated on drawings.

C. Remove all existing concrete pads supporting electrical equipment complete. Existing concrete pads shall not be re-used.

D. Remove abandoned wiring to source of supply.

E. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

F. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

G. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

H. Remove abandoned conduit, wire, boxes, and fastening devices including abandoned conduit, wire, boxes, and fastening devices above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

I. Remove conduit, wire, boxes, and fastening devices to avoid any interference with new installation.

J. Reconnect equipment being disturbed by renovation work and required for continued Service.

K. Disconnect or shut-off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring that are not part of final project.

L. Install temporary wiring and connections to maintain existing systems in service during construction.

M. Perform work on energized equipment or circuits with experienced and trained personnel.

N. Remove, relocate, and extend existing installations to accommodate new construction.

O. Repair adjacent construction and finishes damaged during demolition and extension work.

P. Remove exposed abandoned grounding and bonding components, fasteners and supports, and electrical identification components, including abandoned components above accessible ceiling finishes and below raised floor areas. Cut embedded support elements flush with walls and floors.

Q. Clean and repair existing equipment to remain or to be reinstalled.

R. Protect and retain power to existing active equipment remaining.

S. Cap abandoned empty conduit at both ends.

T. Repair adjacent construction and finishes damaged during demolition and extension work. T-bar ceiling tiles damaged under normal construction conditions or having voids where junction boxes were removed shall be replaced by the Contractor.

U. Maintain access to existing electrical installations which remain active.

V. Where materials or equipment are to be turned over to Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain condition of materials and equipment equal to the existing condition of the equipment before the work began. Repair or replace damaged materials or equipment at no additional cost to the Owner.

3.5 EXISTING PANELBOARDS

A. Ring out circuits in existing panel affected by the Work. Where additional circuits are needed, reuse circuits available for reuse. Install new breakers.

B. Disconnect and tag unused circuits as spare.

C. Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding Project area or are not in use.

D. Remove existing wire no longer in use from panel to equipment.

E. Provide new updated directories where circuits have been modified or rewired.

3.6 LAMP DISPOSAL

A. Contractor shall be responsible for the careful removal of all lamps and fluorescent tubes without breakage from existing lighting fixtures.

B. Lamps removed from fluorescent, metal halide, mercury vapor, and sodium fixtures shall be placed by the Contractor in cardboard boxes. The Contractor shall label each box with type and quantity of lamps in each box and seal the box. Boxes shall be properly disposed of by the Contractor.

C. Broken, fluorescent, metal halide, mercury vapor, and sodium lamps without green end caps shall be immediately and carefully cleaned up by the Contractor and placed in a 55 gallon steel drum. 55 gallon steel drums shall properly dispose of by the Contractor.

D. All incandescent lamps shall be disposed of by the Contractor in his dumpster.

3.7 MASONRY UNIT REMOVAL AND REPLACEMENT

A. Carefully demolish or remove entire concrete masonry unit (CMU) block face from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with new full-size CMU block face.

B. Support and protect remaining masonry that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.

C. Clean CMU surrounding removal areas by removing mortar, duct, and loose particles in preparation for replacement.

D. Install replacement CMU into bonding and coursing pattern of existing units. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.

E. Lay replacement units with completely filed bed, head, and collar joints. Butter ends with sufficient mortar to fill head joints and shove into place. Wet both replacement and surrounding masonry that has ASTM C67 initial rates of absorption of more that 30 g/30 sq. in. per min. Use wetting methods that ensure that units are nearly saturated, but surface is dry when laid. Maintain joint width for replacement units to match existing joints.

F. Tool exposed mortar joints in repaired areas to match joints of surrounding existing masonry.

G. Rake out mortar used for laying masonry before mortar sets and point new mortar joints in repaired area to comply with requirements for repointing existing masonry, and at the same time as repointing of surrounding area.

H. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or fiber brushes, and clean water, spray applied at low pressure. Do not use metal scrapers or brushes. Do not use acidic or alkaline cleaners.

I. Wash adjacent non-masonry surfaces. Use detergent and soft brushes or cloths suitable for surface material being cleaned.

J. Sweep and rake adjacent pavement, concrete and ground to remove masonry debris. Where necessary, pressure wash surfaces to remove mortar, dust, dirt and stains.

3.8 SALVAGE

A. It is the intent of this section to deliver to the Owner all components of any electrical system (including fire alarm systems) which they may want to salvage. The Contractor shall make every effort to remove reusable components without damage. Coordinate removal with the owner and deliver to maintenance all items the owner requests from demolition. These items typically include switchgear, fire alarm system, public address system, etc.

B. All salvaged equipment shall be delivered to Owner.

3.9 REUSABLE ELECTRICAL EQUIPMENT

A. Carefully remove equipment, materials, or fixtures that are to be reused.

B. Disconnect, remove, or relocate existing electrical material and equipment interfering with new installation.

C. Relocate existing lighting fixtures as needed. Test fixture to see if it is in good working condition before installation at new location. Disconnect or shut off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring that are not part of final project.

3.10 CLEANING AND REPAIR

A. Remove demolished materials as work progresses. Legally recycle or dispose.

B. Keep workplace neat on a daily basis.

C. Clean and repair existing materials and equipment which remain or are to be reused.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260508 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 COORDINATION

A. The Contractor is expressly directed to read the General Conditions and all sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Plumbing Fire Protection, Mechanical and Structural drawings, to the end that complete coordination between trades will be affected. Each Contractor shall make known to all other contractors the intended positioning of materials, raceways, supports, equipment and the intended order of his work. Coordinate all work with other trades and proceed with the installation in a manner that will not create delays for other trades or affect the Owner's operations.

B. Special attention to coordination shall be given to points where raceways, fixtures, etc., must cross other ducts or conduit, where lighting fixtures must be recessed in ceilings, and where fixtures, conduit and devices must recess into walls, soffits, columns, etc. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.

C. The Contractor shall be responsible for coordination with all trades to ensure that they have made provision for connections, operational switches, disconnect switches, fused disconnects, etc., for electrically operated equipment provided under this or any other division of the specifications, or as called for on the drawings. Any connection, circuiting, disconnects, fuses, etc. that are required for equipment operation shall be provided as a part of this contract.

D. Review and coordinate connections to electrically operated equipment furnished by other trades with project contract documents, shop drawings, submittals, and installation instructions. Notify architect in writing of discrepancies prior to proceeding with work. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.

E. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other trade's work, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.

F. In all areas where air diffusers, devices, lighting fixtures and other ceiling-mounted devices are to be installed, the Mechanical Trade(s), the Electrical Trade and the General Trades shall coordinate their respective construction and installations so as to provide a combined symmetrical arrangement that is

acceptable to the Architect and Engineer. Where applicable, refer to reflected ceiling plans. Request layouts from the Architect or Engineer where in doubt about the potential acceptability of an installation.

G. Refer to equipment schedules and details on all contract documents for additional information for mechanical and plumbing connections. Provide labor and materials for a complete and operable system.

H. Provide equipment overcurrent protection and feeder sizes for equipment furnished by this or other trades or by Owner per actual equipment nameplates and installation instructions.

I. Provide weather-proof/weather-resistant maintenance receptacles within 25 feet of all mechanical and plumbing units/equipment. Coordinate installation locations with final equipment layout provided by Mechanical Contractor. Provide GFI branch circuit for each maintenance receptacle to nearest panelboard unless circuit is otherwise noted on drawings.

1.3 INTERFACING

A. Each Electrical Trade, Specialty Controls Trade, Mechanical Trade and the General Trades, etc., shall ensure that coordination is affected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

1. Connection of all controls to equipment.
2. Electrical power connections to electrically operated (or controlled) equipment.
3. Electrical provisions for all equipment provided by other trades or suppliers within this contract.
4. Contractor is to provide conduit whips and back boxes, as needed, to power systems furniture.
5. Coordination of connection of Telecommunications (voice, data, video) lines to Owner’s existing or new service.
6. Connection of utility electrical service to Owner's existing or new services.

1.4 CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. Each Contractor shall make all connections to equipment furnished by others, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

B. All drawings are complementary, one trade of the other. It is the Contractor's responsibility to examine all drawings and specifications to determine the full scope of his work. The project Engineers have arranged the specifications and drawings in their given order solely as a convenience in organizing the project, and in no way shall they imply the assignment of work to specific trades, contractors, subcontractors or suppliers.

C. Supervision to assure proper installation, functioning and operation shall be provided by the Contractor furnishing the equipment or apparatus to be connected.

D. Items indicated on the drawings as rough-in only (RIO) will be connected by the equipment supplier or Owner, as indicated. The Contractor shall be responsible for rough-in provisions only as indicated. These rough-ins shall be in accord with the manufacturer's or supplier's requirements.

E. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.

F. The Contractor shall be responsible for coordinating with the General and all other trades, as necessary, to determine any and all final connections that he is to make to equipment furnished by others.

G. Sides of cable, basket and ladder trays shall not be obstructed with special attention to pipes, ductwork, raceways, equipment, cables, etc.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER, CONDUCTORS, CABLES, SPLICING DEVICES AND CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. This section of the Specifications covers all of the electrical power, lighting, and control power (line voltage) conductors, but does not include communications, data or signal system conductors, which are specified separately in these specifications.

C. All conduits installed without conductors shall have a 200 lb. test nylon string installed for future use, tied off securely at each end.

D. No more than 40% conduit fill is permitted for any conduit system, including video, intercom, data, power or other signal circuits unless specifically indicated otherwise on the plans.

E. No more than seven conductors (six current-carrying and one ground) shall be installed in a conduit except for switch legs and travelers in multi-point switching arrangements. Multi-wire branch circuits with a shared neutral are not allowed.

F. If multiple circuits are pulled in a single homerun, a dedicated neutral shall be provided for each phase conductor. In these cases, a maximum of seven conductors (six current carrying and one ground) are permitted in a single conduit. Conductors shall be derated per NEC.

G. Intentional or unintentional painting of exposed low voltage or line voltage cabling is prohibited. The contractor shall ensure that exposed cabling is adequately protected from direct painting or overspray whether painting is required within the electrical specifications or required by other disciplines/trades. The contractor shall review the painting requirements for all disciplines and shall provide cabling protection as required. Where exposed cabling is being installed in exposed ceiling or wall spaces that are required to be painted, the contractor shall provide alternate options for cable colors and shall provide submittals for such cabling to engineer for approval.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Coordinate paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

B. Qualification Data: For testing agency.

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 member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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:

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire Company.
3. American Insulated Wire Corp.; a Leviton Company.
4. Belden Inc.
5. Cerro Wire LLC.
6. Encore Wire Corporation.
7. General Cable Technologies Corporation.
8. General Cable Corporation.
9. Senator Wire & Cable Company.
10. Southwire Company.

B. All conductors shall be 98% conductive annealed copper unless otherwise noted, UL listed and labeled. Comply with ANSI/NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation:

1. Comply with ANSI/NEMA WC 70/ICEA S-95-658.
2. Lighting and receptacle branch circuits shall be Type THW, THHN or THWN insulation.
3. All feeders shall be Type THW or THWN of the size as shown on the Contract Drawings.
4. THHN wiring shall only be installed in overhead, dry or damp locations.
5. THWN OR THW wiring shall be used for all circuits pulled in underground or other wet locations.

D. Conductor sizes indicated on drawings are based upon 75 degree C rating.

E. Minimum branch circuit or feeder size shall be not less than #12 AWG copper wire or of the sizes shown on the drawings.

F. Conductors #10 AWG and smaller shall be solid. Conductors #8 AWG and larger sizes shall be stranded.

G. Conductors for fire alarm wiring shall be stranded and in full compliance with NEC 760. All fire alarm conductors shall be installed within conduit and enclosed junction boxes. Exposed cabling in air plenums shall be rated for plenum installation.

H. All wire on the project shall be new, in good condition, and shall be delivered in standard coils or reels.

I. The color of the wire shall be selected to conform to Section 210-5 of the latest edition of the National Electrical Code. Power conductors of all sizes shall follow the color coding scheme listed under PART 3, IDENTIFICATION below.

J. Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible.

K. Conductors for main ground from neutral bus, equipment grounding bus, building steel, grounding grid and main cold water pipe connection shall be bare copper.

L. All conductors shall be identified by color code and by means of labels placed on conductors in all junction boxes and at each terminal point with Brady, Ideal, T & B or approved equivalent labels indicating source, circuit number or terminal number.

M. Branch wiring and feeder conductors that are greater than 50' in length shall be increased at least one size to compensate for voltage drop. All circuits shall be installed and sized for a maximum 2% voltage drop. As calculated using 80% of the supply breaker rating as the load. Adjust conductors and conduit size accordingly for actual field installed conditions.

N. No aluminum conductors shall be used.

O. MC cable is acceptable for the following applications:

1. Feeders for lighting fixture whips and for branch circuits concealed in walls and partitions only. Locate junction box and convert to single conductors in rigid raceway within the same room as where the cable enters/exits the wall.
2. Use only for single-circuit cable (i.e. two wire plus ground). For devices in the same wall connected to different circuits, install separate single circuit cable for each circuit.
3. The MC cable length for power circuits shall be limited to 30′ from the junction box to the wiring device located in the wall. If the circuit continues outside the wall, the circuit must immediately transition to conduit.
4. The MC cable length for lighting circuits shall be limited to 30′ from the junction box to the first fixture and from that point only those fixtures above the enclosed space/room shall be served by this HCF circuit.

P. MC cable is not acceptable for the following applications:

1. Homeruns to Panelboards.
2. Branch circuits serving Essential Electrical System (Emergency & Standby) loads; including Life Safety branch, Critical branch and equipment emergency system.
3. Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.
4. Within mechanical, electrical or telecommunication equipment rooms.
5. Exposed Branch Circuits within areas that do not have a ceiling (i.e. open to structure).
6. Wet locations.

2.2 SPLICING DEVICES & CONNECTORS

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:

1. 3M; Electrical Products Division.
2. AFC Cable Systems, Inc.
3. Burndy

4. Gardner Bender.
5. Hubbell Power Systems, Inc.
6. Ideal Industries, Inc.
7. ILSCO.
8. NSi Industries LLC.
9. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
10. Reliable
11. T&B
12. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Splicing devices for use on #10 AWG and smaller conductors shall be pressure type such as T&B "Sta-Kon".

D. Wire nuts shall be spring pressure type, insulation 600V, 105°C insulation, up to #8 AWG. Greater than #6 AWG shall be a compression type connection, 600V insulation, cold shrink tubing, taped to restore full insulation value of the wire being spliced.

E. Pressure crimp-applied ring type (or fork with upturned ends) terminations shall be employed on motor and equipment terminals where such terminals are provided on motor and equipment leads or on all stranded wire terminations using #10 AWG or smaller conductors.

F. Splices, where necessary, shall be made with hydraulically-set "Hy-press" or equivalent crimped connectors. All splices shall be insulated to the full value of the wiring insulation using a cold-shrink kit or the equivalent in built-up materials.

G. Large connectors (lugs) at terminals shall be mechanical type, hex-head socket or crimp-on style, installed per the manufacturer's recommendations.

H. Underground connections made between bare ground wires or to ground rods shall be exothermically welded, "Cadweld" or equivalent.

I. No aluminum splicing devices or connectors shall be used.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION MATERIAL APPLICATIONS

A. Feeders and Branch Circuits: Copper. Solid for #10 AWG and smaller; stranded for # 8 AWG and larger.

B. Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible stranded.

C. Conductors used for theatrical lighting branch cables shall be extra flexible stranded.

D. Lighting and receptacle branch circuits shall be Type THW, THHN or THWN insulation.

E. All feeders shall be Type THW or THWN of the size as shown on the Contract Drawings.

F. THHN wiring shall only be installed in overhead, dry or damp locations.

G. THWN or THW wiring shall be used for all circuits pulled in underground or other wet locations.

H. Class 1 Control Circuits: Type THHN-THWN, in raceway.

I. Motor Connections shall use connection lugs with motor stub splice insulators.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.2 INSTALLATION

A. Clean out raceway system before pulling conductors.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. The pulling of all wires and cable on this project shall be performed in strict compliance with applicable sections of the National Electrical Code. No conductor entering or leaving a cabinet or box shall be deflected in such a manner as to cause excess pressure on the conductor insulation. Conductors shall only be installed after insulating bushings are in place.

E. The radius of bending of conductors shall be not less than eighteen times the outside diameter of the conductor insulation or more, if recommended by the manufacturer.

F. Conductors installed within environmental air plenums shall be per NEC. Article 800 and other applicable codes, with FEP-type insulation or an approved equivalent. Also provide plenum-rated tie-wraps where plastic straps or other supports, etc., are installed in plenum areas.

G. Where indicated, systems and control conductors that are installed exposed shall not be routed across ceilings or ductwork. They shall be held up against building structure or against permanent support members. They shall be installed in such a manner that they do not interfere with the access to or operation of equipment or removal of ceiling tiles. Nylon tie-wraps shall be installed in such a manner so as to bundle conductors neatly, allowing runouts of single conductors or groups to drop down to equipment served. Install grommeting where dropping out of trays or into panels or service columns. Install sleeves with bushings where penetrating partitions. Firestop sleeves with approved material. Do not penetrate firewalls if so indicated on plans. Refer to the drawings for support requirements and details on routing exposed communications conductors.

H. Conductors for isolated power systems shall be installed in as short a run of conduit as practicable. No pulling soap shall be used on conductors in isolated power systems.

I. Where conductors are installed in industrial facilities, they shall be per JIC standards.

J. Maximum permissible pulling tensions, as recommended by the manufacturer for any given type of cable or wire installed shall not be exceeded. Utilize special remote readout equipment to ensure compliance. Use particular caution when installing twisted pair data cable or fiber optic cables -- forces permitted for pulling in are typically very low for these cable types.

K. Where multi-wire branch circuits are allowed on the drawings, the phases and neutral shall be wire-tied together in the panelboard and in all pull boxes.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

C. Wiring at Outlets: Install conductors at each outlet with at least 12 inches of slack.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Perform insulation resistance (megger) testing for all bus duct and feeders in accordance with NETA ATS. Testing may be witnessed by the Engineer and/or Commissioning agent. Schedule all tests with Architect with ample notice.
3. Megger tests shall be performed at a DC voltage of 1,000 volts for 600 volt rated equipment, and at a DC voltage of 500 volts for 120-300 volt rated equipment. Minimum acceptable (temperature corrected) resistance is 25 megaohms for 120-300 volt rated equipment and 100 megaohms for 600 volt rated equipment and wiring.
4. Test instruments shall be calibrated to national standards within the last 12 months.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors #3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. Test and Inspection Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

F. Cables will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.

G. Submit test results to Architect and Engineer for approval

3.5 IDENTIFICATION

A. Color coding distribution voltage conductors, 600 volts or less

B. Conductors, in all sizes of cable, shall have continuous insulation color(s) from the manufacturer. Taped ends shall not be acceptable.

1. Conductors shall be color coded as follows:

a. 120/208 Volt Conductors

1) Phase A: Black
2) Phase B: Red
3) Phase C: Blue
4) Neutral: White
5) Ground: Green
6) Isolated Ground: Green/Yellow

b. 277/480 Volt Conductors

1) Phase A: Brown
2) Phase B: Orange
3) Phase C: Yellow
4) Neutral: Gray or White with Brown tracer
5) Ground: Green
6) Isolated Ground: Green/Yellow

c. Isolated Power Conductors (Type XLP or XHHN)

1) Phase A - Brown
2) Phase B - Orange
3) Phase C - Yellow
4) Neutral - White with brown tracer stripe
5) Note: Provide each phase with tracer color other than white, green, or gray.

d. Note: Further identify isolated power conductors with ½" wide purple tape at all terminations and junctions.

2. Fire Alarm Wiring: Red
3. Signal voltage wiring color coding shall be consistent throughout the project and shall match existing equipment and standards where applicable. Color coding for each system shall be unique.
4. Conductors within enclosures that may be energized when enclosure disconnect is off - yellow, or taped with 1/2" yellow tape every 6" of length, inside enclosure. Provide lamacoid plate warning sign on front of enclosure where this condition occurs.
5. DC Wiring: Positive: Light Blue
   Negative: Dark Blue

C. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Foundation steel electrodes.
3. Ground bonding common with lightning protection system.
4. Grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems.

B. All metallic conduit, raceways, cable trays, wireways, supports, cabinets and equipment shall be grounded in accordance with the latest National Electrical Code, as shown on the Contract Drawings and in accord with the requirements of the local authority having jurisdiction, as applicable.

C. The size of the equipment grounding conductors, grounding electrode conductors and service grounding conductors shall be not less than that given in Article No. 250 of the National Electrical Code, and/or as shown on the Contract Drawings. Where ungrounded conductor sizes are increased to minimize voltage drop, grounded conductor sizes shall be increased in the proper proportion.

D. Grounding bus and non-current carrying metallic parts of all equipment and raceway systems shall be securely grounded by connection to common ground.

E. The service entrance main ground bus shall also be connected to the main cold metallic water pipe within three feet of where it enters the building, on both the house and street sides of the main shut-off valve with a properly sized bonding jumper. A properly sized bonding jumper shall also be provided to the frame of any steel structure utilized in the construction. The steel frame of the building (if any) shall be made electrically continuous.

F. All ground electrode systems shall be installed in accordance with manufacturer's recommendations, UL listings, ANSI standards, National Electrical Code and National Electrical Safety Code.

1.3 ACTION SUBMITTALS

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

1. Grounding Systems
2. Ground Rods
3. Ground Wires
4. Connectors and Fasteners
5. Bonding Materials

1.4 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports. Provide the following test reports:

1. Bond resistance test
2. Ground resistance tests
3. Ground isolation test
4. Continuity isolation test

1.5 CLOSEOUT DOCUMENTS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

B. In addition to items specified in Section 260501 "CLOSEOUT DOCUMENTS," include the following:

1. Instructions for periodic testing and inspection of grounding features at building master ground bus and electrodes based on NFPA 70B.
2. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
3. Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Listing and labeling: Provide products specified in this Section that are listed and labeled.

D. Comply with NECA’s “Standard of Installation.”

1.7 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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 UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS:

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

1. Erico
2. ILSCO
3. Cadweld

4. Burndy
5. Therm-O-Weld
6. T&B
7. O.A. Co.
8. Lyncole XIT Grounding
9. Superior Grounding Systems
10. LEC Inc

2.3 CONDUCTORS

A. Comply with Specification Section 260519, LOW-VOLTAGE ELECTRICAL POWER, CONDUCTORS, CABLES, SPLICING DEVICES AND CONNECTORS.

B. 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.

C. Ground wires and cables shall be of the AWG sizes shown on the Contract Drawings or shall be sized in accordance with the prevailing codes. All ground wires and cables shall be copper.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar per EIA/TIA standards.

E. All grounding fittings shall be heavy cast bronze or copper of the mechanical type except for underground installations or interconnection of grounding grid to cable, columns and ground electrodes, which shall be thermically welded type as manufactured by Cadweld, Burndy Co., Therm-O-Weld, or approved equivalent.

2.5 GROUND RODS

A. Copper-clad steel; 3/4 inch in diameter by 10 feet long, molecularly bonded copper to high-strength steel core, copper thickness per UL/ANSI. Ensure ground rods are clean and smooth and have a cone-shaped point. Ensure ground rods are die-stamped near the top with the name and trademark of the manufacturer and the length in feet.

2.6 TELECOMMUNICATION CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

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

1. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.
4. Tyco Electronics Corp.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

E. Cable Tray Grounding Jumper:

1. Not smaller than #2 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. Attach with grounding screw or connector provided by cable tray manufacturer.

2.7 GROUNDING BUSBARS

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

1. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.
4. Tyco Electronics Corp.

B. TMGB and TGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper in cross section and length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-B.

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar per EIA/TIA standards.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with four (2) rows of 9/32-inch holes spaced 1-1/8 inches apart. Minimum length of 18” or as indicated on Contract Drawings
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600V. Lexan or PVC, impulse tested at 5000 V.
4. Predrilling shall be with holes for use with lugs specified in this Section.
5. Mounting Hardware: Stand-off brackets that provide at least a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
6. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
7. Refer to sheet E-8.2 for additional requirements.

C. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

D. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 GENERAL

A. All metallic conduit, raceways, wireways, supports, cabinets and equipment shall be grounded in accordance with the latest issue of the National Electrical Code, as shown on the Contract Drawings and in accord with the requirements of the local authority having jurisdiction, as applicable.

B. The size of the equipment shall be not less than that given in Article No. 250 of the National Electrical Code, and/or as shown on the Contract Drawings.

C. Grounding bus and non-current carrying metallic parts of all equipment and raceway systems shall be securely grounded by connection to common ground.

D. All outlet, junction and pull boxes shall be grounded with pigtail to the equipment grounding conductor.

3.2 APPLICATIONS

A. Conductors: Install solid conductor for #10 AWG and smaller, and stranded conductors for #8 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, #3/0 AWG minimum or as indicated on drawings, whichever is larger.

1. Bury at least 24 inches below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Grounding Bus: Install in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 18 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.3 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral bus and ground bus.

3.4 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Where NEC requires grounding for a separately derived system, ground according to NEC.

B. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.5 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide #1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with #4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.6 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Busway Supply Circuits
8. Computer and Rack-Mounted Electronic Equipment Circuits.

B. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide #4/0 minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-18-inch grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.7 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. All grounding conductors shall be protected from mechanical injury and shall be rigidly supported. Where ground conductors are run through flexible conduit and through panelboard switchboard or motor control center feeders, they shall be securely bonded to such conduit thru the use of grounding bushings at the entrance and exit. All connection of equipment shall be made with an approved type of solderless connection and same shall be bolted or clamped to equipment or conduit.

C. Equipment ground connections to GFI circuit breakers shall be carried and bonded to each outlet on the circuit. Provide a separate equipment grounding conductor with green color insulation.

D. Equipment grounding conductors shall be routed to lighting fixtures, devices, receptacles, electric heaters, furnace and other equipment. Equipment grounding conductors shall be green.

E. Resistance to the grounding at the service entrance equipment shall be in accordance with the NEC for style of construction and shall not exceed five ohms as measured by the described testing method.

F. All circuits shall have a grounding conductor.

G. When grounding systems are completely installed and all grading in the area of the service grounding electrode has been completed up to finish elevations, perform a fall-of potential or other approved test to determine actual system resistance to earth. Report results to the Engineer in writing. Refer to testing provisions in this section of specifications.

H. Where separately-derived systems are utilized as part of the power distribution network, the neutral leg of the secondary side of generators, transformers, etc., shall be connected to a grounding electrode in accordance with the manufacturer's recommendations.

I. The Contractor shall ensure that the ground return path thru building structural steel or other means is electrically continuous back to the service grounding electrode and is of adequate capacity and impedance to carry the maximum expected fault or other current. Where no electrically continuous steel building frame is available, the Contractor shall provide a properly sized ground bar and ground conductor routed back to the main facility ground bus.

J. Where a building's steel frame is made electrically discontinuous by masonry breaks (as at firewalls, etc.), the Contractor shall provide an accessible thermically welded bonding jumper of #500Kcmil copper to bond the building steel frame sections together, making the entire steel frame electrically continuous. The installation of these bonding jumpers shall be reviewed by the Engineer prior to their being covered by construction.

K. Grounding connections shall never be made to fire protection, natural gas, flammable gas or liquid fuel piping, except where specifically indicated on the plans.

L. Where dielectric fittings are utilized in piping systems, the piping system shall not be utilized as a ground path. Bonding jumpers shall not be utilized to bridge over such fittings. Piping systems shall not be utilized as ground paths except where specifically required by codes in the case of water piping.

M. At all metallic outlet, junction and pull boxes, bond the equipment grounding conductor to the box.

N. Ground Rods: Drive rods until tops are 12 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
3. Provide well access for testing at one (1) rod.

O. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

P. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

Q. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

R. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

S. Grounding for Steel Building Structure: Provide a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

T. Concrete-Encased Grounding Electrode (Ufer Ground): Provide and fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than #4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

U. Perform ground testing, log results, and provide reports of test points, test values, and procedure as required by engineer and/or local authority having jurisdiction. All systems shall be grounded to maintain leakage current below levels required by applicable codes and standards.

V. Grounding Busbars:

1. Install busbars horizontally, on insulated spacers 4 inches minimum from wall, 72 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.8 TELECOMMUNICATIONS CONNECTIONS: Electrical Contractor shall perform the following work whether equipment and devices are provided by the Owner, Owner’s Vendor or by the Electrical Contractor:

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than #6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Primary Protector: Bond to the TMGB with insulated bonding conductor.

D. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor shall be as indicated on the drawings.

E. Telecommunications Enclosures and Equipment Racks: electrical Contractor shall bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar. Bond the equipment grounding busbar to the TGB with #2 AWG bonding conductors.

F. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-C.1 and TIA/EIA-568-C.2 when grounding screened, balanced, twisted-pair cables.

G. Rack- and Cabinet-Mounted Equipment:

H. Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

1. Waveguides and Coaxial Cable:

a. Bond cable shields at the point of entry into the building to the TGB and to the cable entrance plate, using No. 2 AWG bonding conductors.
b. Bond coaxial cable surge arrester to the ground or roof ring using bonding conductor size recommended by surge-arrester manufacturer.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
b. Perform tests by four point fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.
5. Substations and Pad-Mounted Equipment shall be 5 ohms or less.
6. Manhole Grounds shall be 10 ohms or less.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.10 SERVICE GROUND TESTING PROCEDURE

A. The actual resistance to earth of the service grounding electrode shall be measured by the Contractor via the fall-of-potential method. This testing shall be accomplished after the grounding electrode has been completely installed and the finished grade is achieved.

B. The results of the testing shall be summarized in a written report by the Contractor, which shall be forwarded to the Engineer for review. The report shall also be included with the operation and maintenance manuals for the Owner's information and future reference. This report is to also contain a

detailed description and illustrations of the testing procedure, along with the name and model number of the testing instrument(s).

C. For the actual testing, the Contractor shall follow the procedures outlined below. A self-contained instrument such as a "Megger" or "Ground OHMMETER" shall be used that is designed to eliminate the influence of stray current effects on the accuracy of the measurements.

D. Connect one side of the instrument to the grounding electrode conductor where it connects to the facility main ground bus (point C1). Disconnect and isolate the grounding electrode conductor for the test.

E. Drive a copperweld reference electrode probe (point C2) into earth between 300 and 500 feet away from C1 and connect to measurement instrument.

F. Drive the movable grounding probe (C3) into earth at ten equally spaced intervals, in a straight line between C1 and C2 points and note the E/I=R resistance readings on a graph at each point.

G. The resistance measurements in OHMS taken from the flat part of the curve shall be averaged to determine the true grounding electrode resistance to earth.

H. At completion of testing, remove reference electrode C2 and all temporary wiring and connections.

I. If actual measurements of grounding electrode indicate a resistance greater than five OHMS, contact the Engineer for instructions. If deemed necessary by the Engineer, additional electrodes shall be placed and the measurement process repeated until the desired ground potential is achieved.

J. Record results for each step in the testing process and include a full report in close-out documentation.

3.11 FUNCTIONAL PERFORMANCE TESTS

A. System functional performance testing is part of the Commissioning Process as specified in Section 019113. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Authority.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes the following:
1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.
3. Isolation pads.

B. Related Sections include the following:

1. Division 26 Section "Vibration Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit

C. LFMC: Liquid-tight flexible metal conduit

D. GRS: Galvanized rigid steel conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.
5. Concrete Based for Equipment.
6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
7. Delegated-Design Submittal: For hangers and supports for electrical systems.
8. Include design calculations and details of trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which hangers and supports will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Items penetrating finished ceiling, including the following:
5. Lighting fixtures.
6. Air outlets and inlets.
7. Speakers.
8. Sprinklers.
9. Access panels.
10. Projectors.

1.7 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.8 COORDINATION

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

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

1.9 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. 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:

a. Allied Tube & Conduit

b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. Thomas & Betts Corporation.
e. Unistrut; Tyco International, Ltd.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Device Box Mounting Brackets: Factory-fabricated sheet steel brackets for support of device boxes adjacent to or between studs.

1. 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:

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.

F. Through-Stud Cable and Raceway Support Clips: Factory-fabricated spring steel clip for cables or raceways where run horizontally through metal studs.

1. 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:

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.

G. Roof-mounted Raceway Support Blocking: Factory-fabricated support blocking for use under roof-mounted raceways. Wedge-shaped blocking constructed of 100% recycled UV-resistant Rubber with integral galvanized steel strut to accept raceway support clips.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Cooper B-Line C-Port series components or a comparable product by one of the following:

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.

H. Tee Bar Grid Box Hanger: Factory-fabricated metal electrical box hanger for supporting boxes at locations between ceiling system t-grid components. Height adjustable for various electrical box depths. Attached to ceiling tee bar with screws or integral clamp for stability. Includes tab for independent support wire attachment.

1. 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:

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.

I. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

J. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, or steel with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    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:

        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    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:

        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Solid, threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NFPA 70, NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except where requirements of this Section are more stringent.

B. Maximum Horizontal and Vertical Support Spacing for Raceway(s): Space supports for EMT and GRS as required by NFPA 70.

C. Minimum Hanger Rod Size for Raceway Supports: Minimum rod size shall be 1/4 inch in diameter.

D. Single Raceways:

1. For Raceways 1-1/4-inch and smaller: Install adjustable steel band hanger suspended on threaded rod.

2. For Raceways larger than 1-1/4-inch: Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods. Size trapeze members, including the suspension rods, based on the support required for the size, and loaded weight of the conduits.

    a. Secure raceway or cable to support with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

E. Multiple Raceways: Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods, where multiple raceways are run vertically or horizontally at the same elevations. Size trapeze members, including the suspension rods, based on the support required for the number, size, and loaded weight of the conduits. Space them as required for the smallest conduit to be supported. Size so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 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.

3.3 SUPPORT INSTALLATION

A. Comply with NFPA 70, NECA 1 and NECA 101 for installation requirements except where requirements of this Article are more stringent.

B. Fasten junction, pull and devices boxes securely to the building construction, independent of raceway system.

C. Install Device Box Mounting Brackets supported between two studs. All device boxes shall be attached to two studs, device box stabilizers shall not be acceptable.

D. Install Through-Stud Cable and Raceway Support Clips where cables or raceways run horizontally through metal studs.

E. Install Tee Bar Grid Box Hanger supported between two ceiling grid tee bars where devices boxes are located flush in recessed suspended ceilings.

1. Install at least one independent support rod from box hanger to structure.

F. Install Roof-mounted Raceway Support Blocking where raceways run on across roofing.

1. Coordinate installation of roof supports with items specified in Division 07 Section "Roof Accessories." Provide products compatible with rooftop materials included in the Work.

G. Provide minimum of two lock nuts per threaded support rod except where lock nut tightens against a threaded socket, one locknut may be used.

H. Support raceways at a distance above suspended ceilings to permit removal of ceiling panels and luminaires.

I. Locate raceways so as not to hinder access to mechanical equipment.

J. Do not secure conductors, raceways, or supports to suspended ceiling hanger rods or wires.

K. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

L. Mounting and Anchorage of Surface-Mounted or Recessed-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts. Where support anchors are required, establish their type and locate in concrete construction before concrete is poured, if possible. Fit each hanger rod with a nut at its upper end, and set nut in a universal concrete insert in the form. Where supported weight exceeds holding strength of a single insert, pass rods through top slot of inserts and interlock with reinforcing steel. Also, where particularly heavy loads are to be supported, suspend hanger rod or rods from a structural angle spanning two or more inserts and securely bolted thereto to distribute the weight.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps.
6. To Light Steel: Sheet metal screws.
7. For Surface-Mounted Items on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to structure by means that meet seismic-restraint strength and anchorage requirements. Attachment to gypsum wall board is not acceptable as sole support means; slotted-channel rack solidly attached to structure or light-gauge metal framing at both ends is required.
8. For Recessed-Mounted Items in Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices to intermediate light-gauge metal framing members on each side of device or provide slotted-channel racks within hollow wall attached to structure by means that meet seismic-restraint strength and anchorage requirements. Attachment to gypsum wall board is not acceptable as sole support means.

M. Do not support any items (equipment, piping, conduit, etc.) exceeding 2 inches in diameter from the bottom of slabs. Where intermediate supports are required between structural members, use slotted steel channels support systems attached to beams or joists in order to avoid attachment to slabs.

N. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars. Verify reinforcing locations with Structural Engineer. X-Ray existing concrete structures as required.

3.4 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.5 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 3 inches larger in all directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.6 PAINTING

A. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260533 - RACEWAYS AND FITTINGS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This section is intended to specify the raceways, conduit, conduit fittings, hangers, junction boxes, splice boxes, specialties and related items necessary to complete the work as shown on the drawings and specified herein.

B. This section specifies basic materials and methods and is a part of each Division 26, 27 and 28 Sections that implies or refers to electrical raceways specified therein.

C. The types of raceways specified in this section include the following:

1. Steel electrical metallic tubing (EMT)
2. Galvanized rigid steel conduit (GRS or RMC)
3. Intermediate metal conduit (IMC)
4. Rigid aluminum conduit (RAC)
5. Flexible metal conduit (FMC)
6. Liquid-tight flexible metal conduit (LFMC)
7. Rigid nonmetallic conduit (RNC)
8. Surface metal raceway (SMR)
9. Metal wireways and auxiliary gutters.
10. Wall ducts and trench ducts.
11. Cable tray or cable trough.
12. Duct banks, and their construction.

D. All raceways, as listed above and otherwise specified herein shall be provided in compliance with latest editions of all applicable UL, NEMA, NEC and ANSI standards. All conduit, raceways and fittings shall be Underwriters Laboratories listed and labeled, or bear the listing of an agency acceptable to the local authority having jurisdiction.

E. Conduit and raceways, as well as supporting inserts in contact with or enclosed in concrete shall comply with the latest edition of all ACI standards and the equipment manufacturer's recommendations for such work.

F. The decision of the Engineer shall be final and binding in any case where a question or inquiry arises regarding the suitability of a particular installation or application of raceways, supports or materials, if other than outlined herein.

G. Minimum size of conduit shall be 3/4" trade size for power and 1-1/4” trade size for voice/data/TV unless otherwise noted on the drawings. All conduit and raceways shall be sized for the number of conductors contained, in accord with the latest edition of the National Electrical Code or any other applicable standards.

H. The installer of raceway systems shall avoid the use of dissimilar metals within raceway installations that would result in galvanic-action corrosion.

I. PVC or other non-metallic conduit shall be rated for the maximum operating temperature that could be developed by the conductors it encloses, while in normal operation.

J. All empty conduit installed anywhere shall have pull-strings installed for future cabling installation. Coordinate with vendors and provide extra pull-strings as required to ensure that when cabling is pulled, conduit still pull-strings installed for future use.

K. Fire Alarm Cabling: All fire alarm conductors shall be installed within conduit and enclosed junction boxes. Provide a completely separate raceway system from power wiring or other raceway systems. All concealed conduit shall be manufactured red – no field painting will be accepted. Exposed conduit in finished spaces shall be painted to match adjacent finishes.

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 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's product data for raceways, conduits, outlet boxes, and wireways.

B. Shop Drawings:

1. Submit Shop Drawings of the complete metal surface raceway system.
2. Shop Drawings shall include sizes and lengths of raceways, inside corners, outside corners, end caps, raceway cover spacing, grounding, branch circuiting and wiring including locations of service entrances, receptacle types and manufacturers, receptacle spacing, and receptacle labeling with proper voltage, phase, circuit and panelboard designations as indicated on the Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney; a brand of EGS Electrical Group.
6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
7. Republic Conduit.
8. Robroy Industries.
9. Southwire Company.
10. Thomas & Betts Corporation.

11. Western Tube and Conduit Corporation.
12. Wheatland Tube Company; a division of John Maneely Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. STEEL ELECTRICAL METALLIC TUBING

1. Electrical metallic tubing (EMT), of corrosion-resistant zinc coated cold rolled steel tubing shall be permitted for concealed installation in dry interior locations.
2. EMT shall not be installed underground, in concrete slabs or where exposed to physical damage. EMT shall be permitted for exposed work in mechanical and electrical rooms and other exposed structure areas where not subjected to physical damage, as determined by the Engineer. All exposed conduit and fittings located within 8'-0" of finished floor shall be rigid steel with threaded connectors.
3. Comply with ANSI C80.3 and UL 797.

D. GALVANIZED RIGID STEEL CONDUIT

1. Galvanized rigid steel conduit (GRS or RMC) shall have a zinc coating inside and outside by means of hot-dip galvanizing. Use only threaded fittings for GRS.
2. Use GRS where subject to physical damage for exposed work in mechanical spaces, within factory or other industrial work areas, for exposed fit-up work on machinery, for exposed exterior damp or wet location work, in hazardous atmospheres, in exterior underground locations where installed beneath roadways, where ells occur in underground PVC conduits, or where turning out of concrete encased duct banks, and at other locations as specifically called out on the drawings.
3. GRS shall be used for all building interior power wiring or cables of over 600 Volts.
4. GRS shall be delivered with plastic protectors on the threads.
5. GRS threads shall not have any coating which will reduce conductivity of the joint.
6. Couplings, bends, elbows and fittings shall be subject to the same requirements as for the straight lengths.
7. Comply with ANSI C80.1 and UL 6.
8. "Kwik-Couple" type fittings are not acceptable.
9. Use polyvinylchloride (PVC) coated rigid steel conduit in accordance with NEMA RN 1, Type 40 (40 mils thick) where underground and in corrosive areas.

E. INTERMEDIATE METAL CONDUIT

1. Unless otherwise indicated on the drawings, intermediate metal conduit (IMC) may be used in any location in place of rigid galvanized steel conduit, as permitted by codes, and as approved by the Engineer.
2. Manufactured in conformance with UL standards.
3. Comply with UL 1242.

F. RIGID ALUMINUM CONDUIT

1. Rigid aluminum conduit shall be permitted for installation indoors in dry locations only. Under no conditions shall it be cast into concrete slabs or pass thru construction where prolonged contact will degrade the aluminum.
2. All ells used in rigid aluminum conduit systems shall be rigid galvanized steel.
3. Manufactured in conformance with UL standards.
4. Comply with ANSI C80.5 and UL 6A.

G. FLEXIBLE METAL CONDUIT

1. Flexible metal conduit may be used only where required for connection to light fixtures, motors and other equipment subject to vibration. It shall be constructed of galvanized steel. It shall be installed with connectors designed for the purpose. All flexible metal conduit shall be installed as a single piece. No joints shall be installed. Flexible conduit shall not be used in wet or dusty locations or where exposed to oil, water or other damaging environments. An equipment

grounding conductor or bonding jumper shall be used at all flexible conduit installations. Flexible metal conduit shall not be used in lengths over six feet for light fixture and three feet for other connections. Flexible metal conduit shall not be used in telephone, fire alarm, intercom, security, and other communication systems.

2. Comply with UL 1.

H. LIQUIDTIGHT FLEXIBLE METAL CONDUIT

1. Weatherproof flexible metal conduit shall be wound from a single strip of steel, neoprene covered, equivalent to "Liquatite" or "Sealtite" Type "UA". It shall be installed in such a manner that it will not tend to pull away from the connectors. Provide strain relief fittings equivalent to "Kellems" as required where subject to vibration. Flexible connections to motors in dusty areas shall be dust-tight, in areas exposed to the weather - weatherproof. Length shall not exceed 3' unless permitted by the Engineer.
2. Comply with UL 360.

I. RIGID NON-METALLIC CONDUIT

1. Polyvinylchloride (PVC) Conduit:
    a. PVC conduit shall be Type II, in conformance with NEMA TC2 and the following:
        1) Schedule 40 and 80, high impact.
        2) Suitable for use with 90ºC rated wire.
        3) Conform to UL Standard 65l and carry appropriate UL listing for above and below ground use.
2. Rigid non-metallic conduit shall be constructed of PVC, nominally schedule 40 weight. If installation will enclose utility company provided conductors, verify exact type required and install in accordance with their standards, where more stringent than this specification in normal building conditions.
3. Rigid non-metallic conduit may be used in exterior wet or damp locations where installed underslab or underground. It shall not be run in interior locations, except with special permission from the Engineer for use in corrosive environments, and then only if protected from physical damage. No rigid non-metallic conduit may be installed in environmental air plenums or cast into above-grade concrete slabs. No rigid nonmetallic conduit may be installed in locations where the ambient temperature might exceed the rating of the raceway.
4. Where rigid non-metallic conduit is placed underground, as for feeder circuits, secondaries or branch circuit runs and where ell is made upward thru a slab on grade, transition the turning ell and the riser to rigid steel conduit to a height of 6" above the concrete slab.
5. Flexible non-metallic conduit shall not be used, except by special permission, obtained in writing from the Engineer.
6. Provide equipment grounding conductors of copper, sized as required by codes, in all circuits installed in rigid nonmetallic raceways.
7. Manufactured in conformance with UL standards.
8. Comply with NEMA TC 2 and NEMA TC 3.

J. RACEWAY FITTINGS

1. Fixture whips shall be 1/2" flexible, with clamp-on steel fittings at each end, six foot maximum length, with insulated throat bushings at each end and bonding locknuts. Wiring thru fixture whips shall be #12 AWG, with #12 AWG ground bonded to outlet at source end.
2. Raceway fittings (or condulets) shall be of gray iron, malleable iron or heavy copper-free cast aluminum. They shall be furnished in proper configurations, avoiding excessive plugged openings. Any openings that are left shall be properly plugged. All coverplates shall be gasketed with neoprene or similar approved materials, rated for the environment. Wiring splices within are not permitted.

3. Where conduit transitions in a run from a cold to a warm environment, (such as at a freezer, refrigerator or exterior wall) sealoff fittings shall be placed on the warm side immediately at the boundary to prevent migration of condensation within raceway systems.
4. Conduit bodies, junction boxes and fittings shall be dust tight and threaded for dusty areas, weatherproof for exterior locations and vapor tight for damp areas. Conduit fittings shall be as manufactured by Crouse Hinds, Appleton, Killark or approved equivalent. All surface mounted conduit fittings as with "FS", "FD", "GUB" Types etc., shall be provided with mounting hubs.
5. Where lighting fixtures, appliances or wiring devices are to be suspended from ceiling outlet boxes, they shall be provided with 3/4" rigid conduit pendants. Outlet boxes shall be malleable iron, provided with self-aligning covers with swivel ball joint and #14 gauge steel locking ring. Provide safety chain between building structure and ballast housing of light fixtures for all fixtures, appliances or devices greater than 10 lbs weight. Fixtures shall be installed plumb and level. Cover pendants shall be finished to match fixtures.
6. UL listed expansion/deflection fitting shall be provided at all locations where a raceway/conduit crosses a structural joint intended for expansion, contraction or deflection. Other approved means may be acceptable with permission of the Engineer. Provide copper ground bonding jumpers across expansion fittings.
7. Fittings for threaded raceways shall be tapered thread with all burrs removed, reamed ends and cutting oil wiped clean.
8. Fittings for EMT conduits 2-1/2" and smaller shall be of steel, compression type. Fittings for sizes larger than 2-1/2" shall be setscrew, with two setscrews each side. Conduit stops shall be formed in center of couplings. All EMT connectors and couplings shall be of formed steel construction. All connectors shall be insulated throat type.
9. Indentation or die-cast fittings shall not be permitted in any raceway system.
10. Compression type fittings shall be utilized for EMT conduit installed in damp or dusty locations, or where otherwise indicated.
11. All conduit fittings shall be securely tightened. All threaded fittings shall engage seven full threads. Fasteners shall be properly torqued to manufacturer's recommendations.
12. Comply with NEMA FB1 and UL 514B.

2.2 SURFACE MOUNTED METAL RACEWAY

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

1. Wiremold
2. Istrol
3. Hubbell

B. Surface metal raceways shall only be provided where indicated on the drawings.

C. System: Provide surface raceway systems for branch circuit and data network voice, video and other low-voltage wiring. Surface raceway system shall consist of raceway bases, covers, pre-divided raceway bases, dual covers, appropriate fittings and device mounting plates necessary for a complete installation.

D. Surface metal raceways shall be constructed of code gauge corrosion-resistant galvanized steel or aluminum extrusions, and finished in an ivory, buff or grey color as selected by the Architect. Finishes shall be suitable for field painting, prepared by the installing Contractor as necessary.

E. Surface metal raceways, where used as raceways only, shall be sized for the conductors indicated. Nominal minimum size of such raceways shall be equivalent to Wiremold Co. Series #700, or equivalent by Walkerduct, Isotrol or other approved manufacturer.

F. Surface metal raceways to be furnished with integral receptacles shall have Simplex Nema 5-20R outlets spaced on centers as indicated on plans. These shall be Wiremold Co. #2200 Series or equivalent Walkerduct, Isotrol or other approved manufacturer.

G. Surface Mounted Aluminum Raceways: ALDS4000 Dual Channel Aluminum Surface Raceway by The Wiremold Company.

1. Material: Alloy 6063-T5 extruded aluminum; minimum thickness 0.050-inches.
2. Finish: Satin, No. 204 clear anodized, 0.004-inch thick, Class R1 Mil-Spec.
3. Device Cover Plates: Suitable to mount commercially available duplex devices, single 1.40" and 1.59" diameter receptacles. GFCI, surge receptacles and other rectangular faced devices, and voice and data jacks. Cover plates shall be removable using standard screwdriver without marring the finish.

H. Surface metal raceways and all components and fittings shall be furnished by a single manufacturer, wherever practical. All trim and cover fittings, flush feed boxes, splices, outlet fittings, etc, necessary for a complete installation shall be provided by the installing contractor. These raceways shall be rigidly mounted with approved fasteners on not to exceed 24" centers in a run, or 6" from ends and on either side of a corner. Refer to plans for notations on exact types of these raceways and outlet configurations.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. Cooper B-Line, Inc.
2. Hoffman; a Pentair company.
3. Mono-Systems, Inc.
4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70. Minimum of 14 guage steel before finishes are applied.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireways of painted steel construction shall be corrosion-resistant, moisture and oil resistant where indicated or necessary. Wireways shall be furnished in nominal sizes of 2 ½ " X 2 ½ ", 4" X 4", 6"" X 6", 8" X 8" or 12" X 12", as indicated on plans. Furnish with hinged covers on all runs and removable covers on all fittings, to allow a continuous unobstructed path for conductor installation. Provide knockouts on all runs, unless otherwise indicated or prohibited by codes.

E. Provide wireways with hangers of same manufacturer, installed so as to allow unobstructed access to wireway interior. Install at not to exceed 8'-0" centers, closer as needed at fittings and turns. Use ¼ " rod hangers minimum for up to 4"X 4", 3/8 " rod minimum up to 8"X 8", ½ " rod minimum for 12" X 12".

F. Wireway Covers: Furnish with continuous hinged covers on all runs and removable covers on all fittings, to allow a continuous unobstructed path for conductor installation.

G. Finish: Manufacturer's standard enamel finish.

2.4 WALL DUCTS

A. Where wall duct type raceways are indicated to be installed flush, they shall be a minimum 3 ½ " deep by 10" wide (or 18" width, as indicated), furnished with screw covers to overlap flange 1" on each side. Covers shall be furnished in nominal 3'-0" lengths. Provide fully grommeted openings or bushed nipples as needed in coverplates to pass cables thru. Where indicated or required, provide transition fittings between horizontal runs of wireway and wall ducts to properly interface each raceway system.

B. Where wall ducts are installed flush either vertically or horizontally as a collector duct, provide proper blocking and support in stud walls, adding a layer of studs as needed to prevent undercutting major structural elements of walls. Trim flange shall be set tight to wall surface with 1/16" tolerance each way.

C. Wall ducts, if indicated to be surface mounted, shall be furnished with flangeless coverplates.

D. All completed systems shall be provided with a factory prime painted finish, suitable for field finish painting.

E. Wall ducts shall be equivalent to Square D Company "RWT" Series, as a standard of construction and quality.

2.5 DUCT BANKS

A. Duct banks are defined as a raceway or raceways installed in underground locations, enclosed in a steel-reinforced concrete envelope. They shall be installed where indicated on the drawings or otherwise required.

B. All concrete used in duct bank construction shall be 3000 PSI minimum 28 day compressive strength unless otherwise noted, in accordance with latest A.C.I. standards. Testing of concrete shall be the responsibility of the Contractor, as directed by the engineer. Place concrete against undisturbed earth, or provide forming as needed.

C. Duct bank raceways shall receive a minimum of 3" concrete cover all sides. Minimum size of any duct bank shall be 12" x 12" square, in cross section. In all cases, local and national codes shall apply to duct bank construction where they exceed the requirements of this specification.

D. Each corner of duct bank shall receive a minimum No. 4 steel reinforcing bar with 2" minimum concrete cover on all sides. Lap bars fifteen diameters at all splices. Reinforcing steel shall be rigidly supported during pour and vibration, and shall be constructed to ASTM standards.

E. Support for encased raceways shall be as recommended by raceway manufacturer, spaced 8'-0" maximum on centers, rigidly fastened to prevent floating of ducts during concrete pours. Supports shall be of a material compatible with the raceway, and shall be of the interlocking type, forming a rigidly braced installation. Provide base type and intermediate type spacers to suit conduit configurations and sizes.

F. Where rigid nonmetallic raceways leave concrete duct banks, a transition to rigid steel conduit shall be made 18" inside the concrete envelope. Under no circumstances shall PVC, EB or similar ducts exit concrete envelope, except where duct bank ties into a manhole wall. Provide bell ends at such terminations and towel duct bank rebars 4" into manhole wall with grout. Refer to details on drawings, as applicable. Slope all raceways within duct bank systems such that they shall drain into manholes or pull boxes. Provide proper drainage at manholes or pull boxes to prevent water accumulation.

G. Where ducts transition thru manholes, pull boxes or at terminating end, each duct shall be specifically identified. A nomenclature as shown on the drawings or as agreed upon by the installer and engineer shall be utilized to identify each individual duct. A permanent means of identifying each duct, such as engraved lamacoid plates or stamped metal tags shall be used.

2.6 SUPPORTS AND HANGERS

A. Coordinate installation of Supports and Hangers with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Supports and hangers shall be installed in accord with all applicable codes and standards. They shall be corrosion - resistant, galvanized or furnished with an equivalent protective coating. All electrical raceways shall be hung independently from the building structure with UL listed and approved materials. Hangers and supports depending from the support systems of other trades work shall not be permitted, except with specific approval in writing from the Engineer. The use of tie wire for support or fastening of any raceway system is prohibited. Perforated metal tape shall not be used for raceway support.

C. No raceway shall be installed on acoustic tile ceiling tees, or in any location that will impair the functioning, access or code-required clearances for any equipment or system.

D. Supports for raceways shall be of materials compatible with the raceway, of malleable iron, spring steel, stamped steel or other approved material. Die-cast fittings are not permitted for supports.

E. The installing contractor shall provide all necessary supports and braces for raceways, in a rigid and safe installation, complying with all applicable codes.

F. Individual conduits routed on building walls, ceilings or equipment shall be secured by two- hole galvanized malleable iron or stamped steel pipe strap or "minerallac" 2-piece straps. The straps are to be anchored by an approved means such as expansion anchors, toggle bolts, through bolts, etc. Where required by codes or other standards, provide spacers behind mounting clamps to space conduits off walls.

G. Supports may not be fastened to roof decking on drive pins.

H. Individual conduits run on building steel shall be secured by means of clamp supports similar and equal to those manufactured by the C.C. Korn Company, Elcen Co., B-Line or approved equivalent. Provide korn clamps, bulb-tee, flange clamps, beam clamps, "minerallacs", etc.

I. Where feasible, vertical and/or horizontal runs of conduit shall be grouped in common hangers on "trapezes" of channel stock as manufactured by "Unistrut" or equivalent, 1-5/8" minimum depth. Utilize conduit clamps appropriate to the channel.

J. Channel strut systems for supporting electrical equipment or raceways shall be constructed of 16 gauge minimum hot dip galvanized steel with 9/16" diameter holes on 8" centers, with finish coat of paint as manufactured by Unistrut, B-Line, Kindorf, or approved equivalent.

K. The minimum diameter of round all-thread steel rods used for hangers and supports shall be 1/4", 20 threads per inch. All-thread rod shall be furnished with a corrosion-resistant finish.

L. Welding directly on conduit or fittings is not permitted.

M. Provide riser support clamps for vertical conduit runs. Riser support clamps shall be of heavy gauge steel construction. Install riser support clamps at each floor level penetration, or as otherwise required.

N. Provide conduit cable support clamps for vertical conductor runs as required or indicated on plans. Clamps to be insulating wedging plug, with malleable iron support ring. Install within properly sized and anchored junction box.

O. Spring steel clips and fittings such as those manufactured by HITT-Thomas, Caddy-Erico, or approved equivalent, with black oxide finish are permitted in any indoor dry location for concealed work, where acceptable to the local authority having jurisdiction.

P. Raceways shall be securely and rigidly fastened in place at intervals specified here-in-before with wall brackets, conduit clamps, approved conduit hangers, or beam clamps. Fastenings shall be made by wood screws or screw type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat treated or spring steel tension clamps on steel work. Bolts, screws, etc. used in securing the work shall be galvanized and of ample size for the service. Assembly bolts, nuts, washers, etc., shall be zinc or cadmium coated. Raceways shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4 inch in concrete joists shall avoid cutting the main reinforcing bars.

Q. The use of perforated iron straps or wire for supporting conduits will not be permitted.

R. Where conduits are installed in groups on a common steel channel type support, each conduit shall be secured by Korns, Unistrut, Kindorf clamps or equal.

S. Rigid conduits, where they enter panelboards, cabinets or pull boxes shall be secured in place by galvanized, double locknuts (one inside and one outside) and non-metallic bushings. All bushings shall have insulating material which has been permanently fastened to the fittings. Bushings for conduit 1-1/2 inches trade size and larger, which are used for power distribution, shall be complete with grounding lug and shall be bonded to the box by means of bare copper wire.

2.7 FIRESTOPPING MATERIALS

A. All conduits and cables penetrating fire or smoke rated floors, walls and ceilings shall be firestopped. Firestopping assembly must be UL listed. All corridor walls, storage room walls and mechanical room walls are to be considered minimum one-hour fire rated. Elevated slabs and floors shall also be considered minimum one-hour rated. Refer to Architectural drawings for additional rating requirements.

B. Provide shop drawings indicating penetration detail for each type of wall and floor construction. Shop drawings must be specific for each individual type. (i.e., one-hour fire rated gypsum wall board with insulated metal pipe penetration.)

C. 3M fire protection products are listed below. Equivalent products may be submitted if they are UL listed.

D. The manufacturer of the firestopping materials must provide on site training for the contractor. The training session shall demonstrate to the contractors the proper installation techniques for all the firestopping materials. The training session shall be four hours minimum. Contact the Engineer prior to conducting this training session.

E. Firestopping materials to include but not limed to the following:

1. 3M fire barrier FS-195 wrap/strip.
2. 3M fire barrier CP 25 caulk.
3. 3M fire barrier MP moldable putty.
4. 3M fire barrier RC-1 restricting collar with steel hose clamp.
5. 3M fire barrier damming materials.
6. 3M fire barrier CS-195 composite sheet.
7. 3M fire barrier fire dam 150 caulk.
8. Steel sleeves.

2.8 SPECIALTIES

A. All EMT terminations at junction boxes, panels, etc. shall be made with case hardened locknuts and appropriate fittings, with insulated throat liners. Insulating terminations shall be manufactured as a single unit. The use of split sleeve insulators is not permitted.

B. All rigid conduit, except main and branch feeders, shall have heavy fiber insulating bushings reinforced with double locknuts. All branch and main feeders shall have insulated bushings with grounding lugs and shall be bonded to enclosures with appropriately sized copper jumpers, except at pad mounted transformers. Bonding jumpers shall be installed as required by the NEC and other applicable codes.

C. All conduit stubbed through floor during construction shall have openings protected with plastic caps approved for this purpose. Connections on both ends of all flexible conduit shall be equivalent to Thomas and Betts, Ideal, Appleton, Efcor, or approved equivalent, rated for the environment.

D. Nylon pull strings shall be provided in all empty conduit and in all conduit installed for other trades. Pull strings shall be left securely tied off at each end.

E. Where spare raceways terminate in switchboards or motor control centers a fishtape barrier shall be provided.

F. All outlet, junction and pull boxes shall be grounded with pigtail to the equipment grounding conductor.

G. All fire alarm raceways in concealed areas, data/mechanical/electrical rooms and above ceilings shall be red. Exposed fire alarm raceways shall match adjacent finishes.

H. All junction, outlet and pull boxes in data/mechanical/electrical rooms and above ceilings shall be identified with panel and circuit designation on outside of covers. All junction, outlet and pull boxes in exposed areas shall be identified with panel and circuit designation on inside of covers.

2.9 COMMUNICATIONS OUTLETS

A. Outlet boxes shall be 5” square by 2-7/8” deep with single or double-gang with raised extension ring.

B. All communications outlets shall be fed with at least (1) 1-1/4” inch EMT conduits, with an absolute minimum number of bends from the outlet to the cable tray, wire way or homerun directly to the Telecommunications room. Pull boxes must be installed after every 270 degrees of bend (including offsets) or 100 feet of the conduit run.

C. When mounting the outlet box in a steel studded wall, use a back brace.

D. Use only compression fittings at joints. No more than one offset in a conduit run, unless additional pull boxes are provided after each offset.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC
2. Concealed Conduit, Aboveground: GRC
3. Underslab Conduit: Concrete encased GRC.
4. Underslab Medium-Voltage Conduit: Concrete encased GRC.
5. Refer to Section 260543, "Underground Ducts And Raceways For Electrical Systems" for additional requirements.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Concealed in Ceilings and Interior Walls and Partitions: EMT, IMC or GRC
2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
3. Damp or Wet Locations: GRC
4. Exposed, Not Subject to Physical Damage: GRC, IMC or EMT. Raceway locations include the following:
    a. Electrical Rooms
5. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms (below 8'-0").
    d. Gymnasiums.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

D. 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 nonmetallic sleeve.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only for new devices on existing block walls or where indicated on Drawings.

G. PVC conduit and plastic molding are not acceptable except in caustic environments.

H. Aluminum is not acceptable in caustic environments.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.

C. Horizontal runs of conduit between outlet boxes in walls shall not be permitted.

D. This Contractor shall lay-out and install all conduit systems so as to avoid any other service or systems, the proximity of which may prove injurious to the conduit, or conductors which it confines. All conduit systems, except those otherwise specifically shown to the contrary, shall be concealed in the building construction or run above ceilings. Size of all conduit shall conform to Annex C, of the National Electrical Code, unless otherwise shown on the Contract Drawings.

E. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

F. Support conduit within 12 inches of enclosures to which attached.

G. No conduit shall be installed in or below poured concrete slabs except with permission of the architect or engineer. Conduit shall be held at least 12" from flues, steam or hot water pipes.

H. Intermediate grade conduit will not be acceptable in place of galvanized rigid steel conduit.

I. All exposed conduit shall be installed with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends unless otherwise shown. All conduit shall have supports spaced not more than eight feet apart. Randomly routed conduits will not be acceptable.

J. Conduit shall be installed in such a manner so as to ensure against collection of trapped condensation. All runs of conduit shall be arranged so as to be devoid of traps. Trapped conduit runs shall be provided with explosion proof drains at low points. Runs of conduit between junctions shall not have more than the equivalent of three 90° bends.

K. Junction boxes shall be installed so that conduit runs will not exceed 50', or as shown on the Contract Drawings. Junction boxes shall be sized per NEC, Article 370.

L. Install electrical raceways in accordance with manufacturer's written instructions, applicable requirements of latest edition of the NEC, and NECA "Standard of Installation", complying with recognized industry practices.

M. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.

N. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure wherever possible, to maximize available space and not restrict other trades.

O. Complete installation of electrical raceways before starting installation of cables or wires within raceways.

P. Bushings shall be provided on conduits to protect cables transitioning from conduits to cable tray pathway.

Q. Provide plastic bushings on the end of all conduit stub-ups.

R. Install electrical raceways in accordance with manufacturer's written instructions, applicable requirements of latest edition of the NEC, and NECA "Standard of Installation", complying with recognized industry practices.

S. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.

T. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure wherever possible, to maximize available space and not restrict other trades.

U. Raceways installed in exterior locations shall receive one coat of primer, two coats finish paint after preparation of galvanizing, color selected by Architect. Exposed raceways in painted interior areas shall be similarly painted.

V. Conduits, cables, raceways, and enclosures under metal-corrugated sheet roof decking shall not be located within 1-1/2" of the roof decking, measured from the lowest surface of the roof decking to the top of the conduit, cable, raceway, or box. GRS is acceptable to route tight to bottom of roof deck.

W. Conduits, cables, raceways, and enclosures are not permitted in concealed locations of metal-corrugated sheet decking type roofing.

X. All conduit, tubing, raceways, ducts and duct banks shall be installed in such manner as to ensure against collection of trapped condensation and raceway runs shall be arranged so as to be devoid of traps.

Y. Where conduits pass through exterior concrete walls of facilities, the entrance shall be made watertight. This shall be done by providing pipe sleeves in the concrete with l/2" minimum entrance seal.

Z. All necessary precautions to prevent the lodgment of dirt, plaster, or trash in all conduit or tubing, fittings and boxes during construction shall be taken. All conduit in floors, concrete or below grade shall be swabbed free of debris or moisture before wires are pulled.

AA. Liquid-tight flexible steel conduit shall be used for connections to all vibrating equipment, including motors and transformers, with a minimum of 18-inches of flex looped to avoid restraining equipment vibrating.

BB. Stub-ups to Above Recessed Ceilings:

1. Use EMT for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

CC. Grounding bushings and bonding jumpers shall be used on conduit terminations at all junction boxes, pull boxes and cabinets to maintain grounding integrity of conduit system.

DD. Do not install conduits or raceways on exterior facades or within wall cavities.

EE. All conduit and PVC conduits installed below grade or below slabs (where indicated) shall be concrete encased.

FF. Do not drill into bar joists to support raceways or cables.

GG. All utilities and underground conduits shall be surveyed and recorded on as-built drawings.

HH. All exterior conduits and raceways shall be painted.

II. All floor slabs and concrete walls shall be x-rayed before cutting.

JJ. Contractor must maintain a minimum 12" clear space above, 6" below and a minimum 26" clear on one side of all cable trays and wireways (both new and existing).

KK. Absolutely no "LB's" are allowed in any communications conduit installation.

LL. Conduit ends at a wireway will be mechanically fastened, have plastic bushings, and be wire bonded to the wireway.

MM. Underground electric, cable TV, telephone service or other rigid steel conduit and underfloor rigid steel conduit below the concrete floor slab shall be painted with two coats of bitumastic paint, such as "Asphaltum".

NN. All underground or underfloor conduits shall be swabbed free of all moisture and debris before conductors are pulled.

OO. At least two (2) 1" and three (3) 3/4" conduits shall be stubbed from all flush-mounted panelboards into the nearest accessible area for future use. Provide suitable closures for these stubs. Identify each stub with a suitable hang tag.

PP. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.

QQ. All underground conduits shall be buried to minimum depth of 24" from the top of the concrete encasement or raceway to finished grade, unless otherwise noted on plans. Observe minimum burial requirements of local utility company where their standards or regulations apply. Conduits containing primary power conductors, (higher than 600 volts to ground) shall be 48" to top below finished grade, unless otherwise noted on plans. Conduits containing secondary power conductors, (600 volts and less to ground) shall be 36" to top below finished grade, unless otherwise noted on plans.

RR. Provide uni-strut racks where multiple conduits are supported at one location.

SS. Provide separate a completely separate raceway system of conduits, pull-boxes, etc. for each emergency power branch and for normal power for complete separation per NEC.

TT. Where existing panels are flush-mounted in walls, contractor shall cut, patch, and repair existing construction as required for concealed conduit entry for new connections to those panels.

UU. Expansion-Joint Fittings:

1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

VV. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

3.3 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.4 SPECIALTIES

A. All EMT terminations at junction boxes, panels, etc. shall be made with case hardened locknuts and appropriate fittings, with insulated throat liners. Insulating terminations shall be manufactured as a single unit. The use of split sleeve insulators is not permitted.

B. All rigid conduit, except main and branch feeders, shall have heavy fiber insulating bushings reinforced with double locknuts. All branch and main feeders shall have insulated bushings with grounding lugs and shall be bonded to enclosures with appropriately sized copper jumpers, except at pad mounted transformers. Bonding jumpers shall be installed as required by the NEC and other applicable codes.

C. All conduit stubbed through floor during construction shall have openings protected with plastic caps approved for this purpose. Connections on both ends of all flexible conduit shall be equivalent to Thomas and Betts, Ideal, Appleton, Efcor, or approved equivalent, rated for the environment.

D. Pulling lines shall be left in all open conduit systems and shall be non-metallic, left securely tied off at each end cap any unused conduits.

E. Where spare raceways terminate in switchboards or motor control centers a fishtape barrier shall be provided.

F. All metal boxes, junction boxes and pull boxes shall be grounded with pigtails to the equipment grounding conductor.

G. All empty raceways inside switchgear and open spaces shall be capped.

H. All fire alarm raceways shall be red. Painted red conduit will not be accepted. Junction and pull boxes shall be identified with panel and circuit number on covers.

I. All emergency power raceways shall be blue. Painted conduit will not be accepted. Junction and pull boxes shall be identified with panel and circuit number on covers.

J. All conduits in theaters shall be black. Painted conduit will not be accepted. Junction and pull boxes shall be black and identified with panel and circuit number on inside of covers.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260535 - CABINETS, OUTLET BOXES AND PULL BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes: Boxes, enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 CABINETS, OUTLETS AND PULL BOXES

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

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a Pentair company.
7. Hubbell Incorporated; Killark Division.
8. Kraloy.
9. Milbank Manufacturing Co.
10. Mono-Systems, Inc.
11. O-Z/Gedney; a brand of EGS Electrical Group.
12. RACO; a Hubbell Company.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

B. Cabinets for lighting and power, telephone, pull boxes, outlet boxes, or any other purposes specified or shown on the Contract Drawings, shall be constructed of code gauge, galvanized steel with sides formed and corner seams riveted or welded before galvanizing. Boxes assembled with sheet metal screws will not be accepted. Pull boxes shall include all boxes used to reduce the run of conduit to the required number of feet or bends, supports, taps, troughs, and similar applications and shall also be constructed as specified above.

C. All cabinets and boxes for NEMA 1 and 1A application shall be provided with knockouts, as necessary, or shall be cut in the field by approved cutting tools which will provide a clean, symmetrically cut opening. All boxes, except panelboards, shall be provided with code gauge fronts with hex head or pan head screw fasteners. Fronts for panelboards shall be as specified for panelboards.

D. Ceiling outlet boxes shall be galvanized steel, 4" octagonal, not less than 2 1/8" deep, with lugs or ears to secure covers, and those for use with ceiling lighting fixtures shall be fitted with 3/8" fixture studs fastened to the back of the boxes, where applicable. Provide adequate support with at least a 2x safety factor for the anticipated fixture weight.

E. Special size concealed outlet boxes for clocks, speakers, alarms, TV, etc., shall be provided by the manufacturer of the equipment.

F. The location of outlets, as shown on the drawings, shall be considered as approximate only. It shall be incumbent upon this Contractor to study the general building drawings, with relation to spaces surrounding each outlet, in order to make his work fit the work of others and in order that when the devices or fixtures are installed, they will be symmetrically located and will not interfere with any other work or equipment. Any change in fixture or layout shall be coordinated with and approved by the Engineer before this change is made. Regardless of the orientation shown on the drawings, all devices shall be easily accessible when installed.

G. All outlets, pull boxes, junction boxes, cabinets, etc., shall be sized per the current edition of the National Electrical Code.

H. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

I. Outlet boxes and junction or pull boxes shall be threaded for rigid-threaded conduit, dust-tight vapor-tight or weatherproof as required for areas other than for NEMA 1 or 1A application. These shall be as manufactured by Crouse-Hinds, Appleton, Killark, or approved as equivalent.

J. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

K. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

L. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

M. NEMA 1 or 1A outlet boxes or pull or junction boxes shall be as manufactured by Appleton, Steel City, T & B, or approved equivalent.

1. Outlet boxes for switches, receptacles, etc., concealed in walls shall be galvanized steel, 4” x 4” x 2 1/8” deep with plaster cover for the number of devices as required and to be flush with finished wall. Where outlet boxes are installed in walls of glazed tile, brick, concrete block, or other masonry which will not be covered with plaster or in walls covered by wood wainscot or paneling, deep sectional masonry boxes shall be used and they shall be completely covered with the plates or lighting fixtures. This Contractor shall cooperate with the brick layers, block layers and carpenters to insure that the outlet boxes are installed straight and snugly in the walls. Receptacles shall be set vertically in walls.
2. Outlet boxes for data/voice locations shall be as specified in Division 27.

N. Unless otherwise noted on the drawings or in the specifications, outlet boxes shall be installed at the following heights to centerline of box:

Wall Switches, Control Stations	3'-10"
Convenience Outlets	1'-6"
Above Counter, Convenience Outlets	Bottom at 2" above top of backsplash
TV Outlets	1'-6"
TV Outlets - At Wall Brackets	7'-2"
Desk Telephones	1'-6"
Wall-Mounted Telephone	3'-10"
Weatherproof Outlets	2'-2"

Disconnects, Branch Panelboards ..... 5'-0" max. to centerline
Fire Alarm Manual Stations .....3'-10"
Fire Alarm Audio and/or Visual Unit……80" AFF to bottom of device or 6" below ceiling, whichever is lower

Note: Contractor is to refer to Architectural elevations and coordinate device mounting heights, quantities, and locations.

O. Outlet boxes mounted in glazed tile, brick, concrete block or other types of masonry walls shall be mounted above or below the mortar joint. Do Not Split The Mortar Joint.

P. Boxes for more than two (2) devices shall be for number of devices required and shall be one piece. No ganging of single switch boxes will be allowed.

Q. Outlets provided shall have only the holes necessary to accommodate the conduit at the point of insulation and shall be rigidly secure in position. Boxes with knockout removed and openings not used shall be replaced or provided with a listed knockout closure.

R. Exterior outlets shall be die-cast aluminum, weather-proof with gasketed covers and baked on grey enamel finish, per ANSI 61.

S. Boxes up to 4-11/16 square size shall be fastened to their mounting surface with two fasteners of proper size. Larger sizes shall be fastened with four fasteners, minimum.

T. Openings for conduit entrance in cabinets and boxes shall be prefabricated, punched, drilled and/or reamed. The use of a cutting torch for this purpose is prohibited.

U. Aluminum is not acceptable in caustic environments.

2.2 COMMUNICATIONS OUTLETS

A. Outlet boxes shall be 5” square by 2-7/8” deep with single or double-gang with raised extension ring.

B. All communications outlets shall be fed with at least (1) 1-1/4” inch EMT conduits, with an absolute minimum number of bends from the outlet to the cable tray, wire way or homerun directly to the Telecommunications room. Pull boxes must be installed after every 270 degrees of bend (including offsets) or 100 feet of the conduit run.

C. When mounting the outlet box in a steel studded wall, use a back brace.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

C. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Install electrical boxes as required for splices, taps, wire pulling, equipment connections.

E. Do not install flush mounting boxes back-to-back in walls; install with minimum 6-inches separation. Install with 24-inches separation in acoustic rated walls.

F. Do not fasten boxes to ceiling support wires or other piping systems.

G. Support all boxes independently of conduit.

H. Grounding bushings and bonding jumpers shall be used on conduit terminations at all junction boxes, pull boxes and cabinets to maintain grounding integrity of conduit system.

3.2 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260553 - IDENTIFICATIONS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 DEFINITIONS AND ABBREVIATIONS

A. T - Transformer

B. SWGR – Switchgear.

C. SWBD – Switchboard.

D. ATS - Automatic Transfer Switch.

E. MCC - Motor Control Center.

F. DP - Distribution Panel. Electrical distribution panel which is an integral part of a switchboard or switchgear but has its own isolation circuit breaker.

G. P – Panel. Electrical distribution panels with manually operated circuit breakers which feed other distribution panels or directly to loads. These are generally the last distribution panel before the load.

H. N - Normal power system. Annotates that the associated component is part of the Normal Power distribution system and receives no backup power from the Emergency Power distribution system.

I. E - Emergency power system. Annotates that the associated component is part of the Normal Power and Emergency Power distribution systems. In the event of a loss of the supply from the normal power system, the component will receive power from the emergency power system.

J. BKR – Breaker. Switch which interrupts or establishes power flow to its associated load.

K. DISC - Disconnect Switch. Manually operated knife switch which interrupts or establishes power flow to its associated load.

1.4 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

C. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 - PRODUCTS

2.1 FLOOR MARKING TAPE

A. 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.2 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES”

F. Provide warning signs for the enclosures of electrical equipment including pad-mounted transformers, pad-mounted switches, and switchgear having a nominal rating exceeding 600 volts.

1. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters

on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

2. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field. Sign shall be Panduit No. PASO710D72 or approved equal.

2.3 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

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.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.4 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

C. Retain paragraph below to specify type of label for identifying outdoor equipment if specified in "Identification Schedule" Article.

D. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.5 CABLE TIES

A. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Clear

B. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Clear

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Cable Ties: For attaching tags.

1. Indoors: Plenum rated.
2. Outdoors: UV-stabilized nylon.

G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

H. Equipment, disconnect switches, switchgear, switchboards, panelboards, transformers, motor starters, variable frequency drives, special device plates, and similar materials shall be clearly marked as to their function and use. Markings shall be applied neatly and conspicuously to the front of each item of equipment with 1/2" black lamacoid plate (or equivalent) with white letters 1/4" high unless otherwise specified.

I. PANELBOARD DIRECTORIES

1. The Contractor shall provide clearly legible typewritten directories in each electrical panel indicating the area, item of equipment, etc. controlled by each switch, breaker, fuse, etc. These directories are to be inserted into plastic cardholders on back door in each panel. Descriptions shall be approved by the Owner.

   a. EXAMPLES:

      LIGHTS, ROOM 100
      RECEPTION, ROOM 200

2. Any existing panels which are affected by this contractor’s work shall also be provided with new typewritten directories.
3. Provide electronic Excel files of all directories to owner as part of Close-out Documentation.
4. Panel Schedules and circuit numbers on Record Drawings shall match.

J. All electrical distribution equipment shall be provided with a black lamacoid plastic plate with 1/2" white letters for panel designation and 1/4" white letters showing voltage and feeder information. This includes branch circuit panelboards, switchboards, switchgear, disconnect switches, transformers, motor starters, variable frequency drives and lighting control panels, Branch circuit switches shall be designated as to function. Electrical distribution equipment labels shall indicate the source they are fed from, and the circuit number at that source. Clearly indicate the exact label legend to be furnished with each panelboard and switchgear on the shop drawings for each item of equipment prior to submission of shop drawings. Refer to drawings for further details.

K. Where electrical distribution equipment, including branch circuit panelboards, switchboards and switchgear, are connected to an emergency source, the lamacoid plate shall be red, and the word "EMERGENCY" shall be incorporated into the legend. Also, provide similar plates and legends for automatic transfer switches, as appropriate. Refer to drawings for further details.

L. Lamacoid plates shall be located at center of top of trim for branch circuit panels, switch gear, and centered at side for branch circuit switches. Fasten with self-tapping stainless steel screws or other approved method.

M. All junction boxes utilized for life-safety branch emergency power circuits, connections, devices, etc. shall have the cover painted blue. Mark over paint with panel and circuit number.

N. All concealed junction boxes utilized for fire alarm circuits, connections, devices, etc. shall have the cover painted red. Mark over paint with stenciled letters “FA”.

O. All new receptacle cover plates shall be marked with their panel and circuit number(s) with clear, machine printed adhesive labels with black lettering. Circuit number shall also be hand written inside outlet box with black permanent marker.

P. All systems requiring room names and/or numbers for labeling or programming shall use the Owner’s actual room name and numbering scheme, not floor plans. All reprogramming shall be included as required to accommodate construction phasing.

Q. All junction, outlet and pull boxes in data/mechanical/electrical rooms and above ceilings shall be identified with panel and circuit designation on outside of covers. All junction, outlet and pull boxes in exposed areas shall be identified with panel and circuit designation on inside of covers.

R. The inside of all junction and backboxes shall be marked with panel and circuit number in permanent marker.

S. All identifications shall be consistent with the owner’s standard practices, especially within existing facilities. Where the requirements here-in are in conflict with such standard practices, the contractor shall notify the engineer in writing prior to ordering any material for clarification.

T. Identification shall consist of all UPPER CASE LETTERS.

U. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

V. Apply identification devices to surfaces that require finish after completing finish work.

W. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification devices.

X. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

Y. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

Z. Fire alarm system: Install a nameplate on the fire alarm panel to indicate the panelboard and circuit number supplying the fire alarm system.

AA. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.
3. UPS.

BB. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

CC. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

DD. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

EE. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer and load shedding.

FF. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

GG. Labeling Instructions:

1. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
2. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
3. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
4. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260573 - ELECTRICAL STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Provide a short-circuit, component protection, arc-flash hazard analysis, and protective device coordination study for the electrical distribution system beginning with all power sources and ending with the lowest level power, lighting and receptacle panels, and motor control equipment.

B. This Section includes computer-based, fault-current, arc-flash and overcurrent protective device coordination studies. Hand calculations are not acceptable. Protective devices shall be set based on results of the protective device coordination study.

C. Electrical Studies shall be performed by the Low-Voltage Switchboard manufacturer. All Electrical Studies required by this specification shall be completed within five (5) weeks from award of project. The Electrical Contractor shall provide all required data to Low-Voltage Switchboard manufacturer within one (1) week and the manufacturer will have four (4) weeks to complete the studies.

D. A licensed professional engineer employee of the Low-Voltage Switchboard manufacturer shall provide electrical power system studies for the project using the latest version of one of the approved software packages. The software model files shall be submitted with the report. The analysis shall follow the latest IEEE 1584 guidelines. An example report will be provided by the Owner upon request.

E. Studies specified herein must be submitted and approved prior to release of any affected equipment. Revisions to equipment or devices necessary to meet study recommendations shall be at the Manufacturer’s expense.

F. All adjustments and settings recommended by these studies shall be made prior to any testing.

G. The analysis shall be submitted to the engineer of record prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing.

1.3 PURPOSE

A. The study shall calculate the worst case available short circuit current at each point in the electrical distribution system considering all power sources under all permissible system operating and switching modes. The study shall be performed in accordance with Part 3 of this specification. The overcurrent protective devices shall have an interrupting and/or withstand rating equal to or greater than the available short circuit current at the applicable time band (1/2, 5, or 8 cycle) at the point of application. Discrepancies shall be noted and called to the attention of the Architect/Engineer.

B. The overcurrent protective devices shall be analyzed for adequate short circuit rating. This analysis shall identify any potential insufficient equipment ratings of existing equipment based on actual available utility values.

C. The study shall also include an arc flash hazard analysis for all electrical equipment. The analysis shall determine the flash protection boundary, incident energy, and required level of Personal Protective Equipment (PPE) for workers at the electrical equipment. The arc flash protection boundary and incident energy shall be determined based upon a working distance as defined in per IEEE 1584, based on system voltages The electrical distribution equipment shall be field marked with this information in accordance with NFPA 70E.

D. The above study shall use equipment designation (labeling) that is consistent with the electrical system diagrams. Equipment shall be readily identifiable without the use of a cross reference list.

1.4 SUBMITTALS

A. Product Data: Computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals:

1. The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

    a. Coordination-study input data, including completed computer program input data sheets.
    b. Study and Equipment Evaluation Reports.
    c. Coordination-Study Report.
    d. Short Circuit Study and Coordination Study including all input data.
    e. Study recommendations for device settings, fuse types/ sizes and Equipment Evaluation findings.
    f. Report shall include any identified recommendations for improvements or suggestions for correction of deficiencies for consideration by the Architect/Engineer.
    g. Arc-Flash Hazard Calculations and list of data for Labels, including any recommendations to reduce any PPE Category 4 or higher hazard level to a PPE Category 3 or lower hazard level.

2. The results of the study shall be summarized in report form, for review and approval by the Architect/Engineer.
3. The results of all studies shall include the following:

    a. Descriptions, purpose, basis, and scope of study.
    b. Fault current calculations including definition of terms and guide for interpretation of computer printout.
    c. Tabulations of protective device and equipment ratings versus maximum calculated short circuit duties, and commentary regarding same.
    d. Flash hazard analysis report for newly installed and directly impacted existing electrical equipment. Based on the worst case resulting in Greatest Personnel Hazard.
    e. Time versus current curves with tabulations of overcurrent protective device settings and selective coordination analysis and commentary regarding same.
    f. The above studies shall be submitted to the Architect/Engineer for review and comment, before any labels are printed.
    g. If power company review and/or approval of device settings or fuse types/sizes is required, appropriate data shall be submitted to the power company for review and/or approval. The results of the power company review and /or approval shall be forwarded to the Architect/Engineer and included in the study report.

E. The studies must bear the signature/seal of the Professional Electrical Engineer in the state where the project is located.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 (power system analysis) for general study procedures.

E. Comply with IEEE 1584 (guide for performing arc flash hazard calculations) for Arc Flash calculation procedures.

1.6 Commissioning

A. This section specifies a system or a component of a system being commissioned as defined in Section 019113 Commissioning. Testing of these systems is required, in cooperation with the Owner and the Commissioning Authority. Refer to Section 019113 Commissioning for detailed commissioning requirements.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Discrepancies shall be noted and called to the attention of Architect/Engineer.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.

3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Busway ampacity and impedance.
    g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

B. Data shall be obtained for the power sources (campus 12 kV system and generators), impedance components (transformers, cables and busway), overcurrent protective devices (fuses, circuit breakers and relays) and other relevant equipment such as automatic transfer switches. Cable data (length, quantity per phase, size and type) shall be provided by the electrical contractor. Assumptions should only be used when the actual data is not available and the assumptions should be clearly listed in the report. Assumptions shall be kept to a minimum.

C. A one line diagram shall be provided as part of the analysis and shall clearly identify individual equipment buses, bus numbers used in the analysis, cable information (length, quantity per phase, size and type), overcurrent device information (manufacturer, type and size), transformers, motors, transfer switches, generators, etc.

D. The one line and analysis shall use a numbering scheme where each bus begins with a three digit number followed by a description (e.g., 102 MDPA or 103 ELEV DISC) and each connected circuit breaker or fuse shall have a corresponding designation (e.g., 102-1 MAIN CB, 102-2 ELEVATOR FDR or 103-1 ELEV DISC CB). An example one line will be provided by the Owner upon request.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus

2. Distribution panelboards
3. Branch circuit panelboards
4. Variable Frequency Drives
5. Motor Control Centers
6. Fused and non-fused disconnects
7. Low-voltage transformers
8. Individual circuit breakers
9. Automatic transfer switches
10. Generator
11. Combination starter/disconnects

B. Study electrical distribution system from normal and alternate emergency power sources throughout electrical distribution system for Project, using approved computer software program. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:

a. ANSI C57.12.10
b. ANSI C57.12.22
c. ANSI C57.12.40
d. IEEE C57.12.00
e. IEEE C57.96

2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.
4. Circuit Breakers: IEEE c37.13.

E. Study Report: Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

G. A table shall be included which lists the calculated short-circuit currents (rms symmetrical three phase), equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment at each bus.

H. Any inadequacies shall be called to the attention of the engineer of record and recommendations made for improvements as soon as they are identified.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.

3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
3. Device settings shall protect transformers according to IEEE C57.12.91, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

H. A table shall be included which lists the recommended settings of each circuit breaker and relay.

I. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

J. Deficiencies in protection and/or coordination shall be called to the attention of the engineer of record and recommendations made for improvements as soon as they are identified.

K. The electrical engineer that performed the study shall be responsible to set the circuit breakers according to the analysis once the report has been approved by the engineer of record.

3.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The analysis shall consider multiple possible utility scenarios as well as multiple system configurations where appropriate such as normal and emergency transfer switch positions and different main-tie-main configurations.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system. This includes all switchboards, switchgear, motor-control centers, panelboards, busway and splitters.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment locations. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude

2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendation for arc flash energy reduction

M. The Arc Flash Hazard Analysis shall include recommendations for reducing Arc Flash Incident Energy (AFIE) levels and enhancing worker safety.

N. Results of the Arc Flash Hazard Analysis shall be submitted in tabular form and shall include the following information for each bus location: bus name, protective device name, bus voltage, bolted fault, arcing fault, trip/delay time, equipment type, working distance, arc flash boundary, incident energy and protective clothing category.

3.6 ARC FLASH WARNING LABELS

A. Arc flash labels shall be furnished and installed by the contractor of the Arc Flash Hazard Analysis.

B. The labels shall be 4 inches high by 6 inches wide and printed on a Brady THTEL-25-483-1-WA label type or similar. The arc flash label shall be formatted similarly to the examples shown below (Figure 1) and include the wording indicated in the table (Table 1) for each PPE category.

C. After labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

D. The label shall include the following information, at a minimum:

1. Arc Flash Incident Energy
2. Location designation
3. Nominal voltage
4. Arc Flash protection boundary
5. Hazard risk category
6. Incident energy
7. Working distance
8. PPE category
9. PPE clothing description
10. PPE equipment description
11. Voltage
12. Glove class
13. Shock protection boundaries according to NFPA 70E
14. Analysis date
15. Building name/number
16. Equipment name and the upstream tripping device.
17. Engineering report number, revision number and issue date.

E. Labels shall be machine printed, with no field markings.

F. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings. Provide one arc flash label for all electrical equipment including, but not limited to, the following:

1. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
2. For each 480 and applicable 208 volt distribution panelboard, one arc flash label shall be provided.
3. For each motor control center, one arc flash label shall be provided.
4. For each low-voltage switchboard, one arc flash label shall be provided.
5. For each switchgear, one flash label shall be provided.
6. For medium voltage switches and transformers, one arc flash label shall be provided.

7. For each fused or non-fused disconnect switch, one arc flash label shall be provided.
8. For each generator and automatic transfer switches, one arc flash label shall be provided.
9. For each variable frequency drives, one arc flash label shall be provided.
10. For each combination starter/disconnects, one arc flash label shall be provided.
11. For each fused or non-fused disconnect switch and individual circuit breakers, one arc flash label shall be provided.
12. For each low-voltage transformer, one arc flash label shall be provided.
13. For each company switch, one arc flash label shall be provided.

Figure 1. Example arc flash labels.

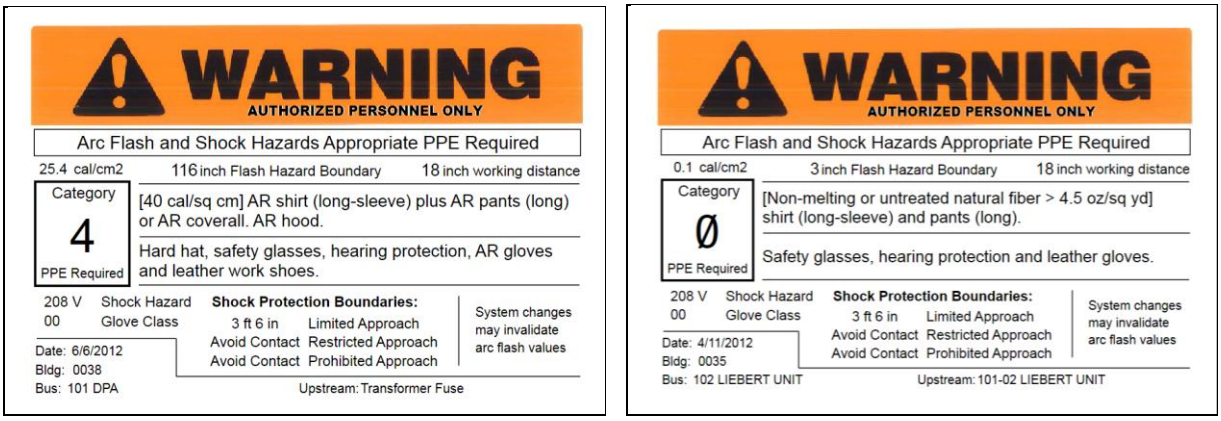

Table 1. Wording for the PPE related arc flash label fields.

Incident Energy (calories/cm^2)	PPE Category	PPE clothing	PPE equipment
0 - 1.2	0	[Non-melting or untreated natural fiber > 4.5 oz/sq yd] shirt (long-sleeve) and pants (long).	Safety glasses, hearing protection and leather gloves.
greater than 1.2 - 4	1	[4 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR faceshield.	Hard hat, safety glasses, hearing protection, leather gloves and leather work shoes.
greater than 4 - 8	2	[8 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR balaclava and AR face shield or AR hood.	Hard hat, safety glasses, hearing protection, leather gloves and leather work shoes.
greater than 8 - 25	3	[20 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR hood.	Hard hat, safety glasses, hearing protection, AR gloves and leather work shoes.
greater than 25 - 40	4	[40 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR hood.	Hard hat, safety glasses, hearing protection, AR gloves and leather work shoes.
greater than 40	X	Arc Flash Energy Exceeds the Rating of Category 4 PPE	Do not work on energized equipment

3.7 INSTALLATION/START-UP

A. The Electrical Contractor shall install equipment and protective devices in accordance with the approved short circuit and selective coordination study.

B. The Electrical Contractor shall field mark equipment with flash hazard analysis data as required in accordance with codes and standards.

C. The Manufacturer's engineer shall set all adjustable overcurrent and/or timing devices in accordance with the approved study results, and then test the devices.

D. The Manufacturer performing the study shall provide assistance to the installing Electrical Contractor during start-up of electrical system and equipment as needed.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 262200 – DRY-TYPE LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This Section includes the following types of dry-type distribution transformers and dry-type shielded isolation transformers rated 600 V and less, with capacities up to 1000 kVA.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code

B. NEMA ST20

C. Underwriters Laboratory (UL) and Canadian Standard Association

1. UL 1561 – Dry-Type General Purpose and Power Transformers
2. CSA C22.2 No.47-M90 Air-Cooled Transformer (Dry Type)

D. UL 250 Enclosure for Electrical Equipment

E. Transformers shall meet the minimum efficiency requirements per DOE 10 CFR Part 431 Energy Conservation program for Commercial Equipment, affective 2016.

F. 2005 Energy Act PUBLIC LAW 109–58—AUG. 8, 2005 Comply with all Rules from Department of Energy

1. 10 CFR 429
2. 10 CFR 431

1.4 STANDARDS

A. Transformers shall be listed by Underwriters Laboratories.

B. Conform to the requirements of ANSI/NFPA 70.

C. Transformers are to be manufactured and tested in accordance with NEMA ST20.

D. Minimum Efficiencies per DOE 10 CFR 431.192 April 2013. Transformers shall comply with the requirements of being built after January 1, 2016. The efficiency of low-voltage dry-type distribution transformer shall be no less than that required for their kVA rating as listed below. Efficiency values are at 35% of nameplate rated load, determined according to the DOE Test Method for Measuring the Energy Consumption of Distribution Transformers under Appendix A to Subpart K of 10 CFR part 431. Low-voltage dry-type distribution transformers with kVA ratings not appearing below shall have their minimum efficiency level determined by linear interpolation of the kVA and efficiency values immediately above and below that kVA rating.

1. Single Phase Low-Voltage Dry-Type Distribution Transformers

a. 15kVA 97.70% Efficient
b. 25kVA 98.00% Efficient
c. 37.5kVA 98.20% Efficient
d. 50kVA 98.30% Efficient
e. 75kVA 98.50% Efficient
f. 100kVA 98.60% Efficient
g. 167kVA 98.70% Efficient
h. 250kVA 98.02% Efficient
i. 333kVA 98.90% Efficient

2. Three Phase Low-Voltage Dry-Type Distribution Transformers

a. 15kVA 97.89% Efficient
b. 25kVA 98.23% Efficient
c. 45kVA 98.40% Efficient
d. 75kVA 98.60% Efficient
e. 112.5kVA 98.74% Efficient
f. 150kVA 98.83% Efficient
g. 225kVA 98.94% Efficient
h. 300kVA 99.02% Efficient
i. 500kVA 99.14% Efficient
j. 750kVA 99.23% Efficient
k. 1000kVA 99.28% Efficient

1.5 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated. Shall Include the following:

1. Confirmation that transformer(s) are UL 1561 Listed with a K-9 Rating.
2. Basic Performance characteristics including insulation class, temperature rise, core and coil materials, impedances & audible noise level, unit weight, inrush data RMS.
3. Efficiency Data
4. No load and full load losses will be calculated per NEMA ST20 test methods.
5. Efficiency Curves

a. Linear Loads
b. Data per the non-linear load test program.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Wire Access Points
3. Wire Bending Dimensions
4. Location for Ground Lug Provisions

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Source quality-control test reports.

C. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

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. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.10 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

1.11 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. All dry-type low-voltage transformers, finishes, and all of its component parts, and controls shall have an unconditional one (1) year warranty. Warranty shall include finishes and all components to be free from defects in materials and workmanship for a period of one (1) year from date of Owner’s acceptance. Replacement of dry-type low-voltage transformers, faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

1.12 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Square D.
2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. General Electric Company.
4. Siemens.
5. ABB.

B. Manufacturers shall be registered firms in accordance with ISO 9001:1994 SIC 3612 (US); which is the design and manufacture of low voltage dry type power, distribution and specialty transformers.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

D. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degeasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use.

1. 1" Minimum Clearance from Rear and Sides

E. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.

F. Comply with NEMA ST 20, and list and label as complying with UL 1561.

G. Cores: One leg per phase.

H. Enclosure: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

I. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

J. Taps shall have a 5% FCAN and 10% FCBN

1. 2.5% Steps On all voltages 350 V and above

a. 15 to 225kVA
b. 300kVA

1) 150°C Rise
2) 80°C Rise change to 5% FCBN instead of 10%

c. 500 and 750kVA range change to 5% FCBN instead of 10%
d. 1000kVA and greater per Manufacture Design

2. 5% Steps On all voltages below 350 V

a. 15 to 225kVA
b. 300kVA

1) 150°C Rise
2) 80°C Rise change to 5% FCBN instead of 10%

c. 500 and 750kVA range change to 5% FCBN instead of 10%
d. 1000kVA and greater per Manufacture Design

K. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

L. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

M. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

N. Wall Brackets: Manufacturer's standard brackets.

O. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.3 Sound levels shall be warranted by the manufacturer not to exceed the following:

1. 15to 50KVA - 39dB
2. 51 to 150kVA - 44dB
3. 151 to 300kVA - 49dB
4. 301 to 500kVA - 54dB
5. 501 to 700kVA - 56dB
6. 701 to 1000kVA - 58dB

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526.

B. Connect wiring according to Section 260519.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections: Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

E. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.

F. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 QUALITY CONTROL/STARTUP:

A. Major equipment and system startup and operational tests shall be scheduled and documented in accordance with Section 019113 Commissioning.

3.6 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.7 CLEANING: Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.8 DEMONSTRATION AND TRAINING

A. Training of the owner’s operation and maintenance personnel is required in cooperation with the Commissioning Authority. The instruction shall be scheduled in coordination with the Commissioning Authority after submission and approval of formal training plans. Refer to Section 019113 and the Commissioning Plan for further contractor training requirements.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DESCRIPTION OF WORK

A. All panelboards shall be of the circuit breaker type, and shall be of one manufacturer.

B. Branch panelboards shall be as indicated on the drawings and as specified herein. The lighting panelboards shall be of the dead-front, quick-make, quick-break, bolt-on circuit breaker type, with trip indicating and trip free handles. All circuits shall be clearly and properly numbered and shall be provided with thermal magnetic protection.

C. The panelboards shall be enclosed in code gauge, galvanized steel cabinets with smooth finished hinged doors without visible external fasteners and heavy chrome locks. Provide baked-on grey enamel finish, in accord with ANSI 61. Panels shall be constructed in accord with Federal Specification W-P-115B Type 1 Class 1, UL67, UL50, NEMA P31, and NFPA 70. Locks shall all be keyed alike.

D. Each door shall have a directory card inside, covered with a plastic shield, with typewritten circuit numbers and description indicated. Room numbers shall be coordinated with final room numbers as selected by Owner, not numbers on Contract Documents.

E. Panelboard trim for surface or flush panels shall be double-hinged type, to allow exposure of dead-front breaker portion behind locked door, with screw-fastened gutter trim that is hinged to allow full access to wiring gutters.

F. Special Note: The room numbers used to fill out the panel directories shall match the actual final name and numbering scheme selected by the Owner. They shall not be filled out per the construction drawing numbering scheme, unless the Contractor is directed to do so by the Architect or Engineer.

G. Branch panelboards shall be surface or flush mounted as indicated on the Contract Drawings. Flush panels trims shall be tight to wall and interior barriers, with no gaps allowing access to live parts. Oversize trims will not be acceptable.

H. Note: Where mounted in groups, align top of trim or tub for all panels in an area. Exact mounting height of topline shall be as directed by the Engineer.

I. All main bus and connections thereto in panelboards shall be copper. All bus bars shall extend full length of panelboards.

J. All panelboards shall have full size un-insulated copper ground busses and insulated full neutral busses.

K. All panelboards shall be provided with an SPD per Specification 264313, Surge Protection for Low-Voltage Electrical Power Circuits.

1.4 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. GFCI: Ground-fault circuit interrupter

1.5 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, surge suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards. Submit final version after load balancing.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for panelboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each panelboard cabinet lock. All keys shall match.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate space available for panelboards including clearances between panelboards and adjacent surfaces and other items. Furnish and install equipment to comply with NEC clearances.

D. 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.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

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

1. Notify Construction Manager no fewer than 14 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager's written permission.
3. Comply with NFPA 70E.

1.12 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.13 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. All panelboards, finishes, and all of its component parts, and controls shall have an unconditional one (1) year warranty. Warranty shall include finishes and all components to be free from defects in materials and workmanship for a period of one (1) year from date of Owner’s acceptance. Replacement of panelboards, faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace surge suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

E. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. All panelboards shall be of the circuit breaker type, and shall be of one manufacturer.

B. Enclosures: Flush- and surface-mounted cabinets. Box width shall not exceed 20" wide. Rated for environmental conditions at installed location.

1. Indoor Dry and Clean Locations: NEMA 250, Type 1.

C. Type 1 Boxes

1. Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvannealed steel is not acceptable.
2. Boxes shall have removable end walls. End walls shall not be provided with concentric knockouts. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes: Panels, Back Boxes and Trim: Galvanized Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
8. All lock assemblies shall be keyed alike.

D. Incoming Mains Location: Top and bottom to match feeder conduit entry. Feeders routed through the side gutters to reach the top or bottom main breakers from the opposite end of the panel are not acceptable.

E. Phase, Neutral, and Ground Busses:

1. Material: Fully plated, hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Extend full length of panelboard and adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box. Provide where show on drawings.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Provide when supplied by K rated transformers.
5. Split Bus: Vertical buses divided into individual vertical sections.

F. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Main and Neutral Lugs: Mechanical type.
2. Ground Lugs and Bus-Configured Terminators: Mechanical type.
3. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
4. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
5. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

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

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
4. Siemens.
5. ABB.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike. For doors more than 36 inches high, provide two latches, keyed alike.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
4. Siemens.
5. ABB.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

E. Interior:

1. Continuous main current ratings, as indicated on associated drawings.
2. Short circuit rating as shown on the schedules.
3. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing shall be plated copper. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
4. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
5. A solidly bonded copper equipment ground bar shall be provided.
6. Split solid neutral shall be plated and located in the mains compartment up to 250 amperes so all incoming neutral cable may be of the same length.
7. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have filler plates covering unused mounting space.
8. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, CSA/UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Circuit breakers shall be CSA and UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panelboard schedules.
2. Molded case branch circuit breakers shall have bolt-on type bus connectors.
3. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
4. There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red indicator appearing in the clear window of the circuit breaker housing.
5. The exposed faceplates of all branch circuit breakers shall be flush with one another.
6. Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors.
7. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
8. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
9. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
10. Instantaneous trip.
11. Long- and short-time pickup levels.
12. Long- and short-time time adjustments.
13. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
14. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
15. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
16. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
17. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    d. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    e. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Equipment Mounting: Install floor-mounted panels on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 90 inches above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four (4) 1-inch and two (2) 1-1/4”-inch empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

K. Comply with NECA 1.

3.3 IDENTIFICATION

A. Each door shall have a directory card inside, covered with a plastic non-yellowing shield. Directory Card to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer to create directory in Microsoft Excel; handwritten directories are not acceptable. Digital versions to be provided to Owner.

B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553.

C. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.6 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 262726 - WIRING DEVICES AND PLATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This section of the specifications covers all wiring devices and cover plates, standard, weatherproof and dust-tight.

B. Wiring devices, listed by manufacturer and catalogue numbers are to establish the quality and type required. Equivalent devices of other manufacturers will be acceptable with prior approval of the Engineer. Submit cutsheets and/or samples of each type ten days prior to bid date for review and written approval to bid. Insofar as possible, standard application or special application devices shall be by one manufacturer.

C. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge-suppression units.
4. Tamper-resistant receptacles.
5. Weather-resistant receptacles.
6. Snap switches and wall-box dimmers.
7. Cord and plug sets.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENT

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.8 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
2. Leviton Mfg. Company Inc. (Leviton).
3. Pass & Seymour/Legrand (P&S).
4. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, 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.

C. Straight-Blade Receptacles

1. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
2. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

    a. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

3. Tamper-Resistant, Shutter-Type Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

D. SPD Receptacles

1. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral SPD in line to ground, line to neutral, and neutral to ground.

a. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
b. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

2. Duplex SPD Convenience Receptacles: Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
3. Isolated-Ground, Duplex Convenience Receptacles:

a. Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.3 DEVICES

TYPE	**RATING**	**CONFIGURATION**	**COLOR**	**VENDOR - CAT. #**
RECEPTACLE, DUPLEX **PREMIUM GRADE**	125V, 20A	NEMA 5-20R	!	HUBBELL 5352 LEVITON or P & S Equal
	* USE WHERE ON DEDICATED 20A CKT., OR CALLED OUT ** USE WHERE ON DEDICATED 15A CKT., OR WHERE MORE THAN ONE RECEPTACLE ON A CIRCUIT			
RECEPTACLE, SAFETY SHUTTER TYPE DUPLEX	125V, 20A	NEMA 5-20R	!	HUBBELL, LEVITON, or P & S equal
RECEPTACLE, DUPLEX GFI WITH AUDIBLE ALARM	125V, 20A	NEMA 5-20R	!	P & S 2095 TRAN LEVITON or HUBBELL equal
RECEPTACLE, DUPLEX, WEATHER RESISTANT, GFI	125V, 20A	NEMA 5-20R	!	HUBBELL # GFTR20 LEVITON OR P & S Equal
RECEPTACLE, SIMPLEX	125V, 20A	NEMA 5-20R	!	HUBBELL 5361
RECEPTACLE, SINGLE	250V, 20A	NEMA 10-20R	BLACK	HUBBELL 6810 LEVITON or P & S Equal
RECEPTACLE, SINGLE	250V, 30A	NEMA 6-30R	BLACK	HUBBELL 9330 LEVITON or P & S Equal
RECEPTACLE, SINGLE	250V, 50A	NEMA 6-50R	BLACK	HUBBELL 9367 LEVITON or P & S Equal
SWITCH, SINGLE POLE	120/277V, 20A	SPST	!	HUBBELL HBL-1221 LEVITON or P & S

				Equal
SWITCH, THREE-WAY	120/277V, 20A	3-WAY	!	HUBBELL HBL-1223 LEVITON or P & S Equal

NOTES:
1. PROVIDE MATCHING CAP (PLUG) FOR ALL RECEPTACLES 30 AMP RATED AND ABOVE AS REQUIRED FOR EQUIPMENT.
2. ALL RECEPTACLES SHALL BE BACK OR SIDE-WIRED, CLAMPING TYPE
3. RECEPTACLES SHALL BE TAMPER RESISTANT AND WEATHER RESISTANT AND MARKED ACCORDINGLY AS REQUIRED BY NEC

! SEE PART 2.5, COLOR.

2.4 SMALL MOTOR CONTROL SWITCHES

A. For small line-to-neutral motor loads of 3/4 HP or less, single phase, rated at 120 or 277 volts, provide snap-type, HP rated motor starter switch with thermal overloads. Overload heaters sized to match the motor nameplate amperes and the ambient temperature shall be provided. Provide with NEMA 1, NEMA 3R or other enclosure suitable for the location and atmosphere. All manual starters in finished areas shall be in flush-mounted enclosures. If the motor to be controlled is not equipped with internal thermal overload protection, overload heaters sized to match the motor nameplate amperes and the ambient temperature shall be provided. Hubbell, Square D or GE.

2.5 COLOR

A. Color of devices shall be as selected by the architect. Samples (devices, plates or both) may be required to be submitted with other architectural color items by the Contractor. The Contractor shall coordinate any such submission required with other trades, the Prime Contractor or as needed.

B. Where devices are controlling or supplying emergency power from a standby source, the device color shall be red, as with switch toggles or receptacle fronts. Plate color shall match others on normal power in the building unless otherwise noted.

C. Where surface finishes next to the devices vary in color or shade throughout the project, the Contractor may be required to provide lighter or darker plates and devices to more closely match wall finishes. These variations are considered to be included in the original contract for construction.

2.6 PLATES AND COVERS

A. Unless otherwise specified or noted, all wiring device plates and covers shall be (smooth thermoplastic, Hubbell "P" Series or equivalent G.E. or Leviton). Color shall match device unless otherwise indicated. Plates shall have circuit and panel designation engraved in the face.

B. Plates for use on emergency outlets shall be engraved with the word “Emergency”. Plates for use on isolated ground outlets shall be engraved with the words “Isolated Ground”.

C. Cover plates shall be of one manufacturer insofar as possible.

D. Weatherproof, while in use, plates for GFCI receptacles shall be cast aluminum, self-closing, gasketed, suitable for standard box mounting, UL listed for wet location use, cover closed. Vertical mounting - Hubbell WP26M, horizontal mounting - Hubbell WP26MH (die-cast zinc) or equivalent Leviton or P & S.

E. Weatherproof switch plates for toggle-handle switches shall be clear silicone rubber, for standard outlet boxes. Hubbell 1795 or equivalent P & S or Leviton.

F. Cover plates for computer, telephone or other system outlets shall be as color and finish to match receptacle plates in each space specified in other sections.

G. All kitchen and food service area plates shall be smooth 304 stainless steel with foam gasket behind to help prevent water infiltration.

2.7 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:

C. Description:

1. Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
2. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.8 PENDANT CORD-CONNECTOR DEVICES

A. Description:

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.9 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. All wiring devices in dusty areas, exposed to weather and moisture shall be installed in Type "FS" conduit fittings having mounting hubs, with appropriate cover plates.

C. Devices that have been installed before painting shall be masked. No plates or covers shall be installed until all finishing and cleaning has been completed.

D. Provide GFCI duplex feed-thru style receptacles where indicated or required by the National Electrical Code, whether specifically called out or not. When a GFCI receptacle is on a circuit with other non-GFCI receptacles, it shall always be placed at the homerun point of the circuit and shall be wired to ground-fault interrupt protect the downstream outlets on that circuit unless specifically indicated to the contrary. Provide a "GFCI protected" label on each downstream outlet. GFCI receptacles shall audibly alarm when tripped.

E. All receptacles shall be installed with ground prong at bottom position.

F. All device face plates shall be labeled with panel and circuit designation by means of machine printed adhesive tape. Select face plates shall be engraved. Refer to drawings.

G. All device boxes shall have circuit number identified within the box.

H. Coordination for all receptacles except NEMA 5 Configuration: Contractor shall confirm receptacle configuration of all special purpose receptacles prior to installation and provide devices to match equipment. Contractor shall replace any incompatible receptacle discovered during owner move-in.

I. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

J. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

K. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. Use a torque screwdriver when a torque is recommended or required by manufacturer.
6. When conductors larger than #12 AWG are installed on 15- or 20-A circuits, splice #12 AWG pigtails for device connections.
7. Tighten unused terminal screws on the device.
8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
9. Install switches with “OFF” position down.

L. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

M. Dimmers:

1. Install slide type dimmers within terms of their listing. Dimmers shall match load type.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to NEC and manufacturers' device listing conditions in the written instructions.

N. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION: Comply with Division 26 Section "Identification for Electrical Systems.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Wiring device will be considered defective if it does not pass tests and inspections.

C. Tests for Convenience Receptacles:

1. Line-Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers and motor-control centers.
2. Spare fuse cabinet.

1.3 SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.
4. Fuse size for elevator feeders and elevator disconnect switches.

B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:

a. Let-through current curves for fuses with current-limiting characteristics.
b. Time-current curves, coordination charts and tables, and related data.
c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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. Comply with:

1. NEMA FU 1 – Low Voltage Cartridge Fuses.
2. NFPA 70 – National Electrical Code.
3. UL 198C – High-Interrupting-Capacity Fuses, Current-Limiting Types.
4. UL 198E – Class R Fuses.
5. UL 512 – Fuseholders.

1.5 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Fuses: Equal to ten (10) percent of quantity installed for each size and type, but no fewer than three of each size and type.

C. Fuse Pullers: Two (2) for each size and type.

1.7 WARRANTY

A. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace fuses that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Owner’s acceptance.

1.8 PROJECT CONDITIONS

A. A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.9 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.3 FUSE APPICATIONS

A. Circuits 601 to 6000 amperes shall be protected by current limiting BUSSMANN HI-CAP TIME DELAY FUSES KRP-C. Fuses shall employ "O" rings as positive seals between the end bells and the fuse barrel. Fuses shall be a time-delay type and must hold 500% of rated current for a minimum of 5 seconds, clear 20 times rated current in .01 seconds or less and be listed by Underwriter's Laboratories, Inc., with an interrupting rating of 200,000 amperes RMS symmetrical. The fuses shall be UL Class L.

B. Circuits 0 to 600 amperes shall be protected by current limiting BUSSMANN LOW-PEAK Dual Element Fuses, LPN-RK (250 volts) or LPS-RK (600 volts). All dual element fuses shall have separate overload and short circuit elements. Fuse shall incorporate a spring activated thermal overload element having a 284NF melting point alloy and shall be independent of the short-circuit clearing chamber. The fuse shall hold 500% of rated current for a minimum of l0 seconds and be listed by Underwriters Laboratories, Inc. with an interrupting rating of 200,000 amperes RMS symmetrical. The fuses shall be UL Class RK1.

C. Motor Circuits - All individual motor circuits rated 480 amperes or less shall be protected by BUSSMANN LOW PEAK DUAL-ELEMENT FUSES LPN-RK (250 volts) or LPS-RK (600 volts). The fuses for 1.15 service factor motors shall be installed in rating approximately l25% of motor full load current except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuse should be 150% to 200% of the Type KRP-C HI-CAP Time Delay Fuses of the rating shown on the drawings. 1.0 service factor motors shall be protected by BUSSMANN LOW-PEAK Dual-Element Fuses LPN RK (250 volts) or LPS-RK (600 volts) installed in rating approximately 115% of the motor full load current except as noted above. The fuses shall be UL Class RK1 or L.

D. Circuit breaker panels shall be protected by BUSSMANN LOW-PEAK Dual Element fuses LPN-RK (250 volts) or LPS-RK (600 volts) as shown on the drawings. The fuses shall be UL Class RK1.

2.4 LIGHTING BALLAST/DRIVER/TRANSFORMER FUSES

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

1. Cooper Bussman, Inc. – GLR fuses with HLR holder.
2. Tracor, Inc.; Littelfuse, Inc. Subsidiary – LGR fuses with LHR-000 holder.
3. Ferraz Shawmut, Inc. – SLR fuses.

B. Provide each lighting ballast/driver/transformer with individual protection on the line side.

C. Provide fuse and holder mounted within or as part of the fixture.

D. Provide fuse size and type recommended by the fixture manufacturer.

2.5 SPARE-FUSE CABINET

A. Manufacturer: Bussmann #SFC-FUSE-CAB spare fuse cabinet or equal.

B. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

C. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.

D. Finish: Gray, baked enamel.

E. Identification: "SPARE FUSES" in 1-1/2 inch high white letters on black lamicoid plate. Mount plate on exterior of door.

F. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Fuses shall be installed when equipment is ready to be energized, including thorough cleaning and tightening of all electrical connections.

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

3.2 INSTALLATION

A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energizing at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energizing of the circuit in which it is applied.

B. No fuses shall be installed in the equipment until the installation is complete, including tests and inspections required prior to being energized. All fuses shall be of the same manufacturer to insure retention of selective coordination, as designed.

C. Provide a complete set of fuses for all fusible devices. Arrange fuses so rating information is readable without removing fuse.

D. Install spare-fuse cabinet(s). Locate in Main Electrical Room.

E. Upon completion of the building, the Contractor shall provide the Owner with spare fuses in Spare-Fuse Cabinet.

3.3 IDENTIFICATION

A. Install as part of the lamicoid identification labels indicating fuse rating and type on outside of the door on each fused switch.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 265113 - LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Interior Luminaires
2. Building Mounted Exterior Luminaires
3. Exit Signs
4. Lamps, Ballasts and Drivers
5. Luminaire Supports and Accessories

1.3 DESCRIPTION OF WORK

A. This work consists of providing all labor, materials, accessories, mounting hardware and equipment necessary for an operationally and aesthetically complete installation of all luminaries, including power wiring, control wiring and accessories, in accordance with the contract documents.

B. Contractor shall coordinate with Vendors and other trades, in advance of installation work, to define all infrastructure and installation requirements. Contractor shall coordinate all infrastructure requirements with all approved lighting equipment prior to infrastructure installation. This includes, but not limited to, appropriately sized, positioned, and located junction boxes, structural supports, feeds, power conduits and control conduits, and remote code-compliant power-supply enclosures.

C. Contractor shall provide all luminaires, as herein specified, complete with lamps, drivers, power supplies, ballasts and accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.

D. All luminaires, items, equipment and parts furnished and specified herein shall bear the “UL Approved” label (or other NRTL label) to indicate compliance with UL requirements. All luminaires shall be manufactured in strict accordance with the appropriate and current requirements of the National Electrical Code as verified by Underwriters Laboratories, Inc. (UL), or tested to UL standards by other nationally recognized testing laboratory (NRTL) as acceptable to Building Officials and Code Administrators International (BOCAI); the International Conference of Building Officials (ICBO); or other relevant code authority recognized by the local jurisdiction within which the project is being constructed. Such a listing shall be provided for each luminaire type, and the appropriate label or labels shall be affixed to each luminaire in a location as required by code or law. All luminaires shall be UL/NRTL listed and labeled for installation in fireproof or non-fireproof construction, dry, damp, or wet locations, as required.

E. All available finishes and colors, for each luminaire, shall be submitted to the Architect for selection during shop drawing review. Premium finishes shall be provided at no additional cost premium.

F. Specifications and drawings are intended to convey all salient features, functions and characteristics of the luminaires only, and do not undertake to illustrate or set forth every item or detail necessary for the

work. Minor details, not usually indicated on the drawings nor specified, but that are necessary for proper execution and completion of the luminaries, shall be included, the same as if they were herein specified or indicated on the drawings.

G. The Owner, Architect and Engineer shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the light fixtures. The responsibility of accurately fabricating the light fixtures to the fulfillment of the specification rests with the Contractor.

H. Where emergency battery packs are provided with fixtures (if any), they shall be connected to an un-switched power line and wired in accord with applicable codes and the manufacturer's recommendations.

I. Refer to architectural details as applicable for recessed soffitt fixtures or wherever fixture installations depend upon work of other trades. Coordinate all installations with other trades. Verify dimensions of spaces for fixtures, and if necessary, adjust lengths to assure proper fit and illumination of diffuser and/or area below.

J. Pre-manufactured flexible wiring systems are not permitted for this project.

K. In accordance with the above and the criteria established herein, the Contractor is responsible for assuring the final design, fabrication and installation which fulfills the requirements of the Contract Documents.

1.4 CODES: Materials and installations shall be in accordance with the latest revision of the National Electrical Code and any applicable Federal, State and local codes and regulations.

1.5 REFERENCE STANDARDS: The publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. The publications may be referred to in the text by the basic designation only.

A. Any references in this specification to lighting mounted in, on, or to the exterior of the building or site are additionally governed by Specification Section 265619 EXTERIOR LIGHTING.

B. American National Standards Institute (ANSI):

1. ANSI C62.41 - Recommended Practice in Low Power Circuits
2. ANSI C78 Series - Physical and Electrical Characteristics of High-Intensity Discharge Lamps
3. ANSI C78.377 - Specifications for the Chromaticity of Solid State Lighting Products
4. ANSI C81 Series - Electric Lamp Bases and Holders
5. ANSI C82.77 - Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
6. ANSI E1.20 - Remote Device Management Over DMX512 Networks
7. ANSI/IES RP-16-10 - Nomenclature and Definitions for Illuminating Engineering

C. Certified Ballast Manufacturers Association (CBM): Requirements for Ballast Certification.

D. Federal Communications Commission (FCC):

1. Code of Federal Regulations (CFR), Title 47, Part 18
2. Part 15 Class B: Radio Frequency Devices, Commercial Rated

E. Entertainment Services and Technology Association: ESTA E1.3 - Entertainment Technology - Lighting Control System - 0 to 10V Analog Control Protocol

F. International Electrotechnical Commission (IEC):

1. IEC 61000-3-2 - Harmonic Current Emissions
2. IEC 61347-1 - General and Safety Requirements for Lamp Control Gear
3. IEC 61347-2-13 - Particular Requirements for Electronic Control Gear for LED Modules
4. IEC 61547 - EMC Immunity Requirements
5. IEC 62384 - DC and AC Supplied Electronic Control Gear for LED Modules - Performance Requirements

6. IEC 62386-101 - Digital Addressable Lighting Interface - Part 101: General Requirements – System
7. IEC 62386-102 - Digital Addressable Lighting Interface - Part 102: General Requirements - Control Gear
8. IEC 62386-207 - Digital Addressable Lighting Interface - Part 207: Particular Requirements for Control Gear - LED Modules (device type 6)

G. Illuminating Engineering Society of North America (IESNA):

1. IES HB-10, IES Lighting Handbook – Tenth Edition
2. IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products, LM-79-08.
3. IES Approved Method for Measuring Lumen Maintenance of LED Light Sources, LM-80-08.
4. IES Approved Method for the Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature, LM-82.
5. IES Projecting Long Term Lumen Maintenance of LED Light Sources, TM-21.
6. IES ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information, LM-63.

H. Institute of Electrical and Electronic Engineers (IEEE): C62.41-91 - Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits

I. National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code (NEC), National Fire Protection Association
2. NFPA 101 - Life Safety Code, National Fire Protection Association

J. National Electrical Manufacturer's Association (NEMA):

1. NEMA FA1, - Outdoor Flood Lighting Equipment
2. NEMA SH5, - Tubular Steel, Aluminum and Prestressed Concrete Roadway Lighting Poles
3. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays, or Systems
4. NEMA SSL3- High-Power White LED Binning for General Illumination
5. NEMA SSL7A - Phase Cut Dimming for Solid State Lighting: Basic Compatibility
6. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronics
7. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

K. OSHA 29CFR1910.7 – Luminaires shall be listed by National Recognized Testing Laboratory Approved by United States Department of Labor.

L. Underwriters Laboratories, Inc. (UL):

1. Underwriters Laboratories (UL) Standards
2. Underwriters Laboratories (UL) Standard for Class 2 Power Units
3. Underwriters Laboratories Safety Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750
4. UL 1310 - UL Standard for Safety Class 2 Power Units
5. UL 1598 - Luminaries
6. UL 924 - Standard for Emergency Lighting and Power Equipment

1.6 ACRONYMS AND DEFINITIONS

A. CCT: Correlated color temperature

B. CRI: Color-rendering index. A measure of the degree of color shift that objects undergo when illuminated by a lamp, compared with those same objects when illuminated by a reference source of comparable correlated color temperature (CCT)

C. CU: Coefficient of utilization

D. IECC: International Energy Conservation Code

E. LER: Luminaire efficacy rating, which is calculated according to NEMA LE 5.

F. Lumen: Delivered output of luminaire.

G. Light Fixture (Luminaire): Complete lighting unit consisting of a lamp(s) and driver(s)/ballast(s) (when applicable) together with the parts designed to distribute the light, to position and protect the lamp(s), and to connect the lamps to the power supply.

H. NRTL: Nationally Recognized Testing Laboratory

I. SPD: Surge Protection Device

J. RCR: Room cavity ratio.

K. UL: Underwriters Laboratory

L. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

M. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.7 EQUAL MANUFACTURERS

A. Manufacturers listed as “Equal” to the Basis of Design on the light fixture schedule shall submit product cutsheets to the Engineer ten (10) days prior to bid for final written approval. This written approval will only be issued in addendum form. “Equal” fixtures shall be of equal or better quality and performance to the fixture(s) listed with manufacturer’s model numbers. Burden of proof shall be on the Contractor, Vendor and manufacturer.

B. Upon request by Engineer, the Contractor shall submit manufacturer’s computerized horizontal illumination levels using AGI32 software in footcandles at workplane (30" above finished floor), taken every 3 feet in every room and area. Include average maintained footcandle levels and maximum and minimum ratio.

1.8 SUBMITTALS

A. Submittal data shall be in accordance with Division 01 SUBMITTAL Specification Section, IECC and as specified herein.

B. Eight (8) copies of light fixture factory shop drawings and cuts, showing fixture dimensions, photometric data and installation data shall be submitted to the Engineer for review 15 days after project award date. (Verify shop drawing quantities with the Architect.)

C. Data, drawings, and reports shall employ the terminology, classifications and methods prescribed by IESNA HB-10, as applicable, for the lighting system specified.

D. When catalog data and/or shop drawings for luminaires are submitted for approval, photometric data from an independent testing laboratory or one participating in the NIST National Voluntary Laboratory Accreditation Program (NVLAP) shall be included with the submittal, indicating average brightness and efficiency of the luminaire specified in specification or as shown on the drawings. Coefficient of utilization data is unacceptable.

E. Product data lacking sufficient detail to indicate compliance with contract documents will be rejected.

F. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. All available finishes and colors for each luminaire type shall be submitted to the Architect for selection during review.
4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for light fixtures.

5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
6. Distribution data according to IESNA classification type as defined in IESNA HB-10.
7. Amount of shielding on luminaires.

1.9 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 and NEMA unless more stringent requirements are specified or indicated.

D. Where groups of luminaire types exhibit the same list of acceptable Manufacturers, such as downlights, accents, and wallwashers, the intent is to have a final installation with the same Manufacturer’s equipment across the groupings as specified for consistency of optics, aesthetics, and similarity of maintenance procedures. Mixing/matching across groups is unacceptable. This also applies to multi-phased projects with single or multiple, but related luminaire types exhibiting the same list of acceptable Manufacturers, except where products have subsequently been discontinued or significantly redesigned in size, appearance, lamping, or gear.

1.10 COORDINATION: Coordinate layout and installation of lighting fixtures with all other construction that penetrates ceilings or is supported by them, including HVAC equipment, plumbing, fire-suppression system and partition assemblies. Refer to Architects reflected ceiling plan (RCP) for locations of all ceiling devices.

1.11 PRODUCT DELIVERY, STORAGE AND HANDLING: The Contractor shall provide, receive, unload, uncrate, store, protect and install lamps, luminaires and auxiliary equipment, as specified herein, in accordance with respective manufacturers' project conditions of temperature and humidity and with appropriate protection against dust and dirt. Lamps for miscellaneous equipment shall be provided and installed by the Contractor according to equipment manufacturers’ guidelines. All products shall be stored in manufacturer's unopened packaging until ready for installation.

1.12 EXTRA MATERIALS

A. Furnish the following extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing content:

1. Single Sided Exit Sign: Furnish at least five (5) of each type.
2. Double Sided Exit Sign: Furnish at least five (5) of each type.
3. LED Drivers: One (1) for every fifty (50) of each type and rating installed. Furnish at least five (5) of each type.
4. LED Lamps/Boards: One (1) for every fifty (50) of each type and rating installed. Furnish at least five (5) of each type.

1.13 WARRANTIES

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. All luminaries, finishes, poles and all of its component parts, and controls shall have an unconditional five (5) year warranty. Warranty shall include all light fixtures, lamps, drivers, poles, finishes and all

components to be free from defects in materials and workmanship for a period of five (5) years from date of Owner's acceptance. Replacement of luminaries, faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. LED drivers: The warranty period shall not be less than ten (10) years from the date of substantial completion. The warranty shall state the malfunctioning LED driver shall be exchanged by the manufacturer and promptly shipped to the Owner. The replacement LED driver shall be identical to, or an improvement upon, the original design of the malfunctioning LED driver.

1.14 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - PRODUCTS:

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide one of the approved products indicated on the Light Fixture Schedule.

B. Subject to compliance with requirements, provide one of the products indicated on Light Fixture Schedule. Refer to Light Fixture Schedule for manufacturers and model numbers. Basis of Design for each light fixture type shall be the first fixture manufacturer and model number for each type listed. Refer to Specification Section 260500, paragraph EQUAL MANUFACTURERS for additional requirements.

C. Manufacturer's catalog numbers together with the descriptions on the drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

D. All luminaires shall be DLC (Design Lights Consortium) Certified.

E. The lighting equipment specified herein has been carefully chosen for its ability to meet the luminous environment requirements of this project. Calculations (with AGi32 or other such software) are generally performed to determine luminances, luminance ratios, and horizontal and vertical illuminances and respective ratios and to assess glare and reflected glare. In some instances, virtual reality "images" have been generated (with AGi32 or other such software) to assist the Lighting Designer, the Architect and/or the Owner in assessing the lighting quality of the space(s). Equipment and/or manufacturers which have been shown to comply with established criteria, including ASHRAE/IES 90.1 and IES guidelines and normal-power lighting requirements as applicable by ordinance, code, Federal law, mandate, or directive, and/or intended LEED certification or other building-rating system, and other lighting standards as deemed appropriate for this specific project is specified herein.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS

A. Comply with the requirements specified in the Articles below and the Light Fixture Schedule.

B. Complete luminaires shall be in accordance with NFPA 70, NEMA, and UL 1598 listed and labeled.

C. Provide luminaires complete with lamps of number, type, and wattage indicated.

D. Ballasts, drivers, or transformers, unless otherwise specificied, shall be field replaceable and shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.

E. Unless otherwise specified, a dedicated means of connecting light source to power shall be used in all luminaires unless otherwise specified and shall meet all UL requirements. LED modules shall be field replaceable.

F. Recessed fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

G. Luminaires shall be entirely factory wired by the luminaire manufacturer in accordance with code and UL requirements and shall be furnished fully compatible with the project electrical wiring and controls system for smooth, continuous, dimming or on/off flicker-free operation.

H. Provide in-line fuse-holders with fuses sized per manufacturer's recommendation for each fixture.

I. Exterior building mounted light fixtures shall be UL classified for damp or wet locations as applicable and shall be complete with gaskets, cast aluminum outlet box and grounding. All dissimilar metal materials shall be separated by non-conductive materials to prevent galvanic action.

J. Provide all luminaires with a specific means for grounding their metallic wireways and housings to an equipment grounding conductor and ground accordingly upon installation.

K. All luminaires shall be provided with a ground wire and grounded accordingly upon installation.

L. All luminaires supplied for recessing in suspended ceilings shall be supplied with pre-wired junction boxes, unless otherwise specified.

M. Provide "maximum wattage label" on all light fixture based on the specified maximum wattage indicated on the light fixture schedule.

N. Metal parts: Free of burrs, sharp corners and sharp edges.

O. Doors, frames and other internal access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers and other components from falling accidently during maintenance and when secured during operating position.

P. Mounting Frames and Rings: If ceiling system and luminaire type requires, each recessed and semi-recessed luminaire shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed as coordinated by Contractor. The frames and rings shall be one piece and of sufficient size and strength to sustain the weight of the luminaire and maintain plumb.

Q. Pendant Supports: Contractor shall be responsible for coordination with Manufacturer, Architect, Structural Engineer and related trades to ensure that proper and adequate structural reinforcement is provided within ceilings to support pendant mounted lighting equipment for a secure, neat, square, plumb appearance. Pendants shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

R. Wall Bracket (Sconce) Supports: Contractor shall be responsible for coordination with Manufacturer, Architect, Structural Engineer and related trades to ensure that proper and adequate structural reinforcement is provided within walls to support wall mounted lighting equipment for a secure, neat, square, plumb appearance. Wall brackets shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

S. All lenses or other light diffusing elements shall be removable for access to lamp and electrical and electronic components and luminaire cleaning, however, they must otherwise be positively and securely held in-place, unless otherwise specified.

T. There shall be no light leaks between the lens and the lens frame. All lens door or holder trim flanges shall fit plumb and flush with the ceiling or wall surface. There shall be no light leaks around the interface between lens door or holder trim flanges and the ceiling or wall.

U. Ballasts, drivers, or transformers, unless otherwise specificied, shall be field replaceable and shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.

V. Unless otherwise specified, a dedicated means of connecting light source to power shall be used in all luminaires unless otherwise specified and shall meet all UL requirements. LED modules shall be field replaceable.

W. Recessed luminaires mounted in an insulated ceiling shall be listed for use in insulated ceilings or provisions made to maintain code-compliant air-space around luminaires in accordance with Vendors' instructions.

X. Unless otherwise specified, luminaire closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

Y. Unless otherwise specified, luminaires with louvers or light transmitting panels shall have hinges, latches and safety catches to facilitate safe, convenient cleaning and relamping. Vapor tight luminaires shall have pressure clamping devices in lieu of the latches.

Z. Yokes, brackets and supplementary supporting members necessary for mounting lighting equipment shall be furnished and installed by the Contractor and approved by the Architect. All materials, accessories, and any other equipment necessary for the complete and proper installation of luminaires, lamps, ballasts/neon transformers included in the contract shall be furnished and installed by the Contractor. All yokes, brackets and supplementary supports shall provide a neat, square, plumb and level appearance, and shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with all lamps, globes, lenses, lens frames or doors etc. in place.

AA. All connections shall be fixed rigid by screws, rivets and/or soldering. Screws and rivets shall not be visible except as necessary for maintenance and/or aesthetic appearance. Soldering shall be ground smooth to a clean, contiguous surface. All connections shall provide a neat, square, plumb and level appearance, and shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

BB. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal and the luminaire styling. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly.

CC. For steel and aluminum luminaires, all screws, bolts, nuts and other fastening and latching hardware shall be a cadmium or equivalent plated. For stainless steel luminaires, all hardware shall be stainless steel. For all bronze luminaires, all hardware shall be bronze.

DD. Extruded aluminum frames and trims shall be rigid and manufactured from quality aluminum without blemishes in the installed product. Miter cuts shall be accurate; joints shall be flush and without burrs and cut alignment maintained with the luminaire located in its final position.

EE. Outdoor Luminaires: Luminaires shall be suitably gasketed and vented according to manufacturer’s instructions. All dissimilar metal materials shall be separated by non-conductive materials to prevent galvanic action.

FF. Luminaires in Hazardous Areas: Luminaires shall be suitable for installation in flammable atmospheres (Class and Group) as defined in NFPA 70 and shall comply with UL 844.

GG. Product procurement and coordination: Contractor shall:

1. Order products according to application
2. Confirm the proper and complete catalog number with distributor and agent.
3. Ensure wiring, driver, etc meets the specifications and proper requirements.
4. Provide additional parts and pieces required to complete the installation in the location and manner intended by the design.

HH. Each light fixture shall be packaged with complete instructions and illustrations on how to install.

II. Each light fixture box, container, etc shall be labeled at the factory with the type designation as indicated on the Light Fixture Schedule.

2.3 LUMINAIRE REFLECTORS AND TRIMS

A. Alzak cones, reflectors, baffles and louvers shall be warranted against discoloration.

B. All cones, reflectors, baffles and louvers shall be removable for lamp access and luminaire cleaning; however, they must otherwise be positively and securely held in-place.

C. All trims, reflectors and canopies shall fit snugly and securely to the ceiling or wall so that no light leak occurs.

D. Trims shall be self-flanged and white, unless otherwise specified.

E. For trimless or flangeless luminaires, Contractor shall coordinate with other Trades to achieve a trimless/flangeless installation acceptable to the Architect. Where ceilings are drywall or plaster, this involves Level 5 finishes or as otherwise directed by the Architect. In drywall, plaster, wood, or stone ceilings, special luminaire collars and exacting coordination are required of Contractor.

2.4 LIGHT EMITTING DIODE (LED) ELECTRONIC DRIVERS: The electronic driver shall at a minimum meet the following characteristics:

A. LED drivers shall comply with NEMA SSL 1, NFPA 70, and UL 8750 unless otherwise specified.

B. All LED luminaires shall use drivers integral to luminaires or as otherwise required by the luminaire manufacturer.

C. Driver shall comply with UL 1310 Class 2 requirements for dry and damp locations, NFPA 70 unless specified otherwise. Drives shall be designed for the wattage of the LEDs used in the indicated application. Drivers shall be designed to operate on the voltage system to which they are connected.

D. LED driver shall withstand up to a 1,000-volt surge without impairment of performance as defined by ANSI C62.41 Category A.

E. LED driver shall tolerate ±10 percent supply voltage fluctuation with no adverse effects to driver or LEDs.

F. LED driver forward voltage (Vf) shall be matched to LED board.

G. LED driver shall exhibit no visible change in light output with a variation of ±10 percent line voltage input.

H. Drivers for luminaires controlled by dimming devices shall be as specified herein and equipped for dimming and conform to the recommendations of the manufacturer of the associated dimming devices to assure satisfactory operation of the lighting system. Contractor shall coordinate all wiring infrastructure to accommodate final-selected drivers and controls systems for smooth, continuous, and flicker-free operation.

I. Flicker: The flicker shall be less than 5 percent at all frequencies below 1000 Hz and without visible flicker. Drivers shall meet or exceed NEMA 410 driver inrush standard.

J. Power factor shall be 0.95 (minimum).

K. Class A Sound Rating.

L. Current crest Factor of 1.5 or less.

M. LED driver total harmonic distortion (THD) shall be less than 20 percent for drivers unless otherwise specified. For dimming drivers, THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.

N. All LED luminaires shall be fused on the primary side of the driver as recommended by the respective luminaire manufacturers.

O. All LED drivers shall be suitably sized to accommodate the LED array consistent with industry standards, including IEC standard 60929 Annex E.

2.5 LIGHT EMITTING DIODE (LED): The light emitting diodes shall as a minimum meet the following characteristic:

A. LED modules shall be manufactured by Cree, GE, Philips, Osram, Niche, or Xicato.

B. LED lamps shall comply with ANSI C78.1.

C. Chromacity of LED lamps shall comply with ANSI C78.377A and NEMA SSL-3.

D. Light emitting diodes shall be tested under IES LM-80 standards.

E. Color Rendering Index (CRI) shall be 84 (minimum).

F. Color temperature of 3,500K, or as indicated on light fixture schedule.

G. Rated lumen maintenance of 90% lumen output at 50,000 hours (minimum).

H. Rated lumen maintenance of 70% lumen output at 100,000 hours (minimum).

I. Provide light fixture types that the LED boards and drivers can be re-placed from the bottom and below ceiling. Trim for the exposed surface of flush-mounted fixtures shall be white or as indicated on light fixture schedule.

J. For color consistency, lamp maintenance consistency and for light output consistency, mixed lamps of the same lamp type from different manufacturers is unacceptable. Use the same brand and date code for all lamps except as otherwise specified. Contractor shall be responsible for coordinating all lamps and brand among all luminaire Vendor(s) and Contractor's respective distributor(s).

2.6 SUSPENDED LUMINAIRES

A. Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation. Hangers shall be cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Hangers shall allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging. Single-unit suspended fixtures shall have twin-stem hangers. Multiple-unit or continuous row fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Rods shall be a minimum 0.18 inch diameter.

B. All suspended luminaires with a weight in excess of 150 pounds shall be fitted with safety cable of sufficient strength and length to meet all UL safety cable load-bearing requirements. Cable shall exhibit a finish (but not painted) compatible with that of the metal finish of the stem/chain/suspension-cable assembly or alternatively finished in black as approved by Architect. Shop drawings shall indicate luminaire weight. Contractor shall coordinate structural support/attachment requirements including independent structure for safety cable attachment with Vendor, Architect, and Structural Engineer and all respective trades. Safety cable shall exhibit sufficient length to wrap tightly and entirely around structural member at least twice before attachment subject to Vendor confirmation of UL requirements and pending Structural Engineer review. Contractor shall provide labor necessary for the stem/chain-assembly-wiring-threading and safety-cable-attachment as instructed by Vendor.

2.7 DOWNLIGHT FIXTURES AND COMPONENTS

A. Downlights shall be listed for thru-branch circuit wiring, recessing in ceilings and damp locations. Where installed in plaster or drywall or other inaccessible ceiling types, they shall be UL listed for bottom access.

B. Provide with tool-less hinged junction box access cover and thermal protection.

C. Provide telescoping channel bar hangers that adjust vertically and horizontally.

2.8 EXIT SIGNS

A. General requirements: UL 924, NFPA 70, AND NFPA 101. Exit signs shall use no more than 5 watts. Housing shall be made of die-cast aluminum. Provide stencil face and red lettering.

B. Provide single or double face as scheduled, indicated on plans or as required by the local Authority Having Jurisdiction. Adjust installation position if required for clear visibility, in accordance with applicable codes.

C. Provide directional arrows (chevrons) as indicated on floor plans and to suit the means of egress or as required by the local Authority Having Jurisdiction.

2.9 LUMINAIRE SUPPORT HANGERS AND COMPONENTS

A. Wires: ASTM A641/A641M, Class 3, soft temper, galvanized regular coating, 0.1055 inches in diameter (12 gage).

B. Straps: Galvanized steel, one by 3/16 inch, conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

C. Rod Hangers: Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

2.10 FUSING: All luminaires shall be fused.

2.11 EQUIPMENT IDENTIFICATION

A. Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

B. Factory-Applied Labels: Provide labeled luminaires in accordance with UL 1598 requirements. All light fixtures shall be clearly marked for operation of specific LED’s and drivers according to proper type. The following characteristics shall be noted in the format "Use Only _____":

1. LED or lamp type, and nominal wattage
2. Driver or ballast type
3. Correlated color temperature (CCT) and color rendering index (CRI)
4. All markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Drivers and ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.12 FACTORY APPLIED FINISH: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Architect’s reflected ceiling plan (RCP) shows actual locations of all light fixtures, diffusers and system devices. Report to the Architect/Engineer any conflicts. Do not scale plans for exact location of lighting fixtures.

B. Install luminaires in accordance with luminaire manufacturer’s written instructions, applicable requirements of NEC, NECA’s “Standard of Installation”, and NEMA standards.

C. Electrical installations shall conform to and meet IEEE C2, NFPA 70, and to the requirements specified herein.

D. Installed luminaires shall be provided with protective covering by Contractor until such time as the space(s) is cleaned and ready for occupancy.

E. Align, mount and level the luminaires uniformly. All luminaires shall be installed plumb/true and level as viewed from all directions. Luminaires shall remain plumb and true without continual adjustment.

F. The Contractor shall coordinate the lighting system installation with the relevant trades so as to eliminate interferences with hangers, mechanical ducts, sprinklers, pipes, steel, etc. Avoid interference with and provide clearance for equipment.

G. Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed.

H. Recessed and semi-recessed fixtures shall be independently supported from the buildings structure by a minimum of four wires per fixture and located near each corner of each fixture. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Round fixtures or fixtures smaller in size than the ceiling grid shall be independently supported from the building structure by a minimum of four wires per fixture spaced approximately equidistant around the fixture. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture. Provide wires for lighting fixture support in this section. Lighting fixtures installed in suspended ceilings shall also comply with the requirements of Division 09 Specification Sections GYPSUM BOARD, ACOUSTICAL PANEL CEILINGS and SUSPENDED DECORATIVE WOOD GRIDS. Support lay-in ceiling light fixtures as follows:

1. Support fixtures with four (4) wires, with one (1) at each corner. Hanger wires shall be installed within 15 degrees of plumb or additional support shall be provided. Wires shall be attached to fixture body and to the building structure (not to the supports of other work or equipment).
2. Where building structure is located such that 15 degrees cannot be maintained, the Contractor shall provide “Uni-strut” or similar structure to meet this requirement.
3. Support Clips: All fixtures shall be furnished with hold down clips to meet applicable seismic codes. Provide four (4) clips per fixture minimum or the equivalent thereof in the installation trim. Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application. Contractor shall install clips per manufacturer’s requirements. If screws are required, they shall be provided.

I. Lighting Fixture Supports:

1. Shall provide support for all of the fixtures.
2. Shall maintain the fixture positions after cleaning and relamping.
3. Shall support the luminaires without causing the ceiling or partition to deflect
4. For installation in suspended ceilings, ensure that the luminaires are supported such that there is no resultant bowing or deflection of the ceiling system.

J. Luminaires installed and used for working light during construction shall be replaced prior to turnover to the Owner if more than 3 percent of their rated life has been used. Fixtures shall be tested for proper operation prior to turn-over and shall be replaced if necessary with new lamps from the original manufacturer.

K. All lamps shall be seasoned for a minimum of 12 hours and a maximum of 100 hours in full-on mode without dimming prior any dimming and prior to turn-over to Owner. All lamps used for convenience lighting during construction for periods collective operation longer than 100 hours and any lamps which have failed/burned-out shall be replaced with identical new lamps, which shall then be seasoned as described above, immediately prior to the date of substantial completion as determined by the Architect.

L. Suspended fixtures shall hang plumb and shall be located with no obstructions within the 45 degree range in all directions. The stem, cable, canopy and fixture shall be capable of 45 degree swing. Suspended

fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints. Steel fixtures shall be supported to prevent "oil-canning" effects. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown.

M. Whenever a luminaire or its hanger canopy is installed directly to a surface mounted junction box, a finishing ring painted to match the ceiling, shall be used to conceal the junction box.

N. Rigidly align continuous rows of light fixtures for true in-line appearance.

O. Exit Signs and Emergency Lighting Units: Wire exit signs ahead of the switch to the un-switched emergency lighting life-safety branch circuit located in the same room or area.

P. Light fixture whips shall be supported from the building structure. Do not clip to lay-in ceiling support wires.

Q. Exterior Fixtures:

1. Exterior building mounted light fixtures shall not be installed until after the building exterior has been rinsed clean of any corrosive cleaning materials. Damaged fixtures shall be replaced by the Contractor at no cost.
2. Provide exterior rated waterproof junction boxes for all fixtures and splices.
3. Utilize weatherproof silicone filled wire nuts and seal all junction boxes and conduit with potting compound to create waterproof barriers. Inspect all splices and fixtures for continuity prior to potting.
4. Lubricate all threaded parts with a high temperature waterproof anti-seize lubricant, including lamp bases and sockets, to prevent seizing and corrosion.
5. All low-voltage wiring to be UV resistant, UL approved for use without conduit, stranded low-voltage wire (Q-Wire by Q-Tran or equal) for use in outdoor and underground applications, gauge as appropriate to avoid voltage drop.
6. Track Lighting: The Electrical Contractor shall allow for all track lighting to be wired with individual home runs (not looped) so invisible feeds (no junction box at end of track) may be utilized.

R. Transformers (applies to all transformers including (but not limited to) low voltage, neon, remote ballast, LED power supplies, exterior locations):

1. Electrical Contractor to locate all transformers (including low voltage, neon, remote ballasts, led power supplies, etc.) near fixtures in a well-ventilated and accessible location. Transformers must be installed (per codes) in accessible areas large enough to dissipate the heat of the transformer. Temperatures should not exceed 100°F (38°C).
2. Transformers should be mounted as close to the load/feed lamp holders as practical to keep the secondary feeds as short as possible.
3. Electrical Contractor to determine wire size according to load and wire length to eliminate voltage drop. If voltage drop is a problem after installation, the Electrical Contractor is responsible for reinstallation (at no additional cost) of transformer and wire to solve problem.
4. Electrical Contractor to label front of transformer with load name and load location. For example: “Large Display Case @ Entry to Main Dining Room.”

S. Light fixture locations in mechanical and electrical equipment rooms/areas, as indicated on floor plans, are approximate. Locate light fixtures to avoid equipment, ductwork, and piping. Locate around and between equipment to maximize the available light. Coordinate mounting heights and locations of light fixtures to clear equipment. Request a meeting with the Engineer if uncertain about an installation. All suspended light fixtures shall be mounted square and plumb.

T. Contractor shall be responsible for sealing all luminaires for wet locations (i.e. all knock-outs, all pipe and wire entrances, etc.) to prevent water wicking.

U. Coordinate between the electrical and ceiling trades to ascertain that approved luminaires are furnished in the proper sizes, with the proper flange details, and installed with the proper devices (hangers, clips, trim frames, flanges), to match the ceiling system being installed.

V. All reflecting surfaces, glass or plastic lenses, ballast housings, parabolic louvers, downlighting alzak cones and specular reflectors and other decorative elements shall be installed after completion of ceiling tile installation, plastering, painting and general cleanup.

W. Handle all reflecting surfaces, glass or plastic lenses, ballast housings, parabolic louvers, downlighting alzak cones and specular reflectors and other decorative elements with care during installation or lamping to avoid fingerprints or dirt deposits.

X. It is preferred that louvers be shipped and installed with clear plastic bags to protect louvers. At close of project, and after construction air filters are changed, remove bags.

3.2 GROUNDING

A. Bond luminaires and metal accessories to the grounding system per National Electrical Code.

B. Ground noncurrent-carrying parts of equipment including luminaires, mounting arms, brackets, and metallic enclosures. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.3 IDENTIFICATION

A. Light fixtures served from multiple power sources, such as emergency fixtures fed from emergency transfer relay, shall have the following label affixed to it:

1. “DANGER - ELECTRICAL SHOCK HAZARD - LIGHT FIXTURE HAS MULTIPLE POWER SOURCES”

3.4 CLEANING

A. At completion of each phase and the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturer.

B. Any louver or cone showing dirt or fingerprints shall be cleaned with solvent recommended by the manufacturer to a like-new condition, or replaced as necessary in order to turn over to the Owner new fixtures at beneficial occupancy.

C. All fingerprints, dirt, tar, smudges, drywall mud and dust, etc. shall be removed by the Contractor from the luminaire bodies, reflectors, trims, and lens/louvers prior to final acceptance. All reflectors shall be free of paint other than factory-applied, if any.

3.5 TESTING AND ADJUSTMENT

A. The lighting and lighting controls systems shall be synchronized and fully operable to address the lighting operation in a complete and code-compliant manner.

B. All adjustable luminaires shall be aimed, focused, locked, etc., by the Contractor under the observation of the Architect. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely by the Contractor.

C. Contractor shall coordinate with Architect to establish the number of two-member crews required for aiming and adjusting. All aiming and adjusting shall be performed after the entire installation is complete for each phase or area. The Contractor shall be responsible for notifying the Architect of appropriate time for final luminaire adjustment.

D. All ladders, scaffolds, lifts, gloves, cleaning cloths, access/adjustment tools, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.

E. Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing lighting effects, aiming shall be accomplished at night.

3.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data in accordance with Division 01 Specification Section SUBMITTALS and OPERATION AND MAITENANCE, IECC and as specified herein, showing all light fixtures, control devices and all interconnecting control wire, conduit and associated hardware.

B. Contractor shall be responsible for obtaining from his supplying light fixture manufacturers, for each type of light fixture, a recommended maintenance manual including, tools required, types of cleaners to be used and replacement parts identification list.

C. Provide at least three (3) CDs/DVDs with high resolution PDF files of all equipment product data for Owner's use in equipment identification and maintenance with recommended maintenance manuals including, at a minimum:

1. Vendor and local representative's contact information
2. Tools required
3. Types of cleaners to be used
4. Replacement parts identification lists
5. Equipment product data (high-quality reproducible copies)
6. Warranty documentation

3.7 FIELD QUALITY CONTROL:

A. Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section.

B. Dimming Drivers. Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.

C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

D. Inspect each light fixture for damage. Replace damaged light fixtures at no cost to the Owner.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to four (4) visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

SECTION 283100 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Contractor's attention is directed to Section 280501 - General Provisions, Communications, and all other Contract Documents as they apply to his work.

1.2 SCOPE OF WORK

A. The work covered by and the intent of this section of the specifications includes the furnishing of all labor, equipment, materials, testing, programming and performance of all operations in connection with the installation of the Fire Alarm System as shown on the drawings, as herein specified and as required by the applicable codes.

B. The requirements of all other applicable conditions of the Contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.

C. The complete installation shall conform to the applicable sections of KBC 909.8, NFPA-71, NFPA-72A, B, C, D, NFPA 92 & 92B, Local Code Requirements and National Electrical Code (Article 760). The requirements of any local fire department and the Authority Having Jurisdiction shall also be observed in the system installation and device layout.

D. The work included in this section shall be coordinated with related work specified elsewhere in these specifications.

E. **Expand existing Fire Alarm System as described herein and as shown on the plans. Provide updated battery calculations, and expand as required to accommodate new devices added to existing fire alarm system.** In general, systems shall include, manual pull stations, automatic fire detectors, horns, flashing lights, annunciator (if indicated), interface with **existing** notification system, raceways, all wiring, connections to devices, connections to valve tamper switches, water flow switches and mechanical controls, outlet boxes, junction boxes, and all other necessary materials for a complete, operating system. All hardware, software, programming, devices and connections to the campus central monitoring system shall be provided under this contract. All functions available at the central monitoring station shall be included.

F. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name of each component. Any catalog numbers specified under this section are intended only to identify the type, quality of design, materials, and operating features desired.

G. The listing of specific catalog numbers and equipment parameters is not intended to limit competition among other manufacturers that propose to supply equivalent equipment and services.

H. Equipment submissions for shop drawing review must include a minimum of the following:

1. Complete descriptive data indicating UL listing for all system components.
2. Complete sequence of operations of the system.
3. Complete system wiring diagrams for components capable of being connected to the system and interfaces to equipment supplied by others.
4. A copy of any state or local Fire Alarm System equipment approvals.

5. An AutoCAD (latest version) produced wiring diagram illustrating the basic floor plan of the building, showing all system wiring and equipment, as well as zoning boundaries and schedule of zone legends as intended to appear on annunciators. Provide three CD-Rom copies of as-built drawings and all system operational software at close of project, to be included in operation and maintenance manuals.

I. No work shall be done until the drawings are approved by the Kentucky Department of Housing, Buildings and Construction.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
6. Include alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified fire-alarm technician, Level IV minimum.
c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Deliver copies to authorities having jurisdiction and include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

    a. Frequency of testing of installed components.
    b. Frequency of inspection of installed components.
    c. Requirements and recommendations related to results of maintenance.
    d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
3. Smoke Detectors: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
4. Detector Bases: Quantity equal to 2 percent of amount installed, but no fewer than 1 unit.
5. Keys and Tools: One extra set for access to locked and tamperproofed components.
6. Audible and Visual Notification Appliances: Ten (10) of each type installed.
7. Fuses: Two of each type installed in the system.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.

D. 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.

E. Every component, device, transmitter, software, etc., that are included in the work, to make up a complete Fire Alarm System shall be listed as a product by the manufacturer under the appropriate category by the Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label.

F. The system power, signal and controls wiring shall be UL listed for Power Limited Applications per NEC 760. All circuits shall be marked in accordance with NEC Article 760.

G. The fire alarm system shall be updated with devices compatible with existing Notifier System.

H. Major equipment and system startup and operational tests shall be scheduled and documented in accordance with Section 019113 Commissioning.

1.8 WARRANTIES

A. The Contractor shall unconditionally guarantee (except for vandalism) the completed fire alarm system wiring and equipment to be free from inherent mechanical, software and electrical defects for a period of one (1) year from the date of Owner's acceptance.

B. The equipment manufacturer shall make available to the Owner a maintenance contract proposal to provide a minimum of two inspections and tests per year in compliance with NFPA-72H and NFPA-92B guidelines.

C. INSTALLATION WARRANTY. The Contractor shall warrant the cabling system unconditionally against defects in workmanship for a period of one year from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. Replacement of faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

D. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

E. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

1.9 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - PRODUCTS

2.1 OPERATION

A. The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:

1. The appropriate initiating device circuit indicator (red color) shall flash on the control panel until the alarm has been silenced at the control panel. Once silenced, this same indicator shall latch on. A subsequent alarm received after silencing shall flash the subsequent zone alarm indicator on the control panel and resound alarms and flashing signals. These same conditions shall occur at any remote annunciator.
2. A pulsing alarm tone shall occur within the control panel until silenced.
3. All alarm indicating appliances shall sound in a temporal code pattern until silenced by an alarm silence switch at the control panel (or the remote annunciator, if any).
4. All doors normally held open by door control devices shall close. Doors shall also be released in the event of incoming normal power failure.
5. A supervised signal to notify the local fire department or an approved central station (as required by local codes) shall be activated.

6. A supervised signal sent to the mechanical control system(s) shall activate, shut down or reconfigure the air handling systems as required by NFPA or as otherwise indicated herein. Provide necessary interlock wiring as required to control mechanical equipment.
7. The Contractors shall coordinate with each other as necessary to provide all required auxiliary contacts, DDC systems interfaces, equipment, etc., as needed to shut down or otherwise control air handling systems per NFPA and all applicable codes.
8. The system shall be wired with two circuits to all Notification devices so that when an alarm is acknowledged, silencing the audibles, the visual units shall continue in operation until the main control panel has been reset. If local codes require other than this arrangement, the system shall be wired in accordance with the code that is applicable.

B. The alarm indicating appliances shall be capable of being silenced only by authorized personnel operating the alarm silence switch at the main control panel or by use of a similar key operated switch at the remote annunciator (where remote units are provided). A subsequent alarm shall reactivate the signals. Operation of the alarm silence switch shall be indicated by trouble light and audible signal.

C. The alarm activation of any elevator lobby shaft, pit or equipment room smoke detector shall, in addition to the operations listed above, cause the elevator cabs to be recalled according to the following sequence:

1. If the alarmed detector is in any location or on any floor other than the main level of egress, the elevator cars shall be recalled to the main level of egress.
2. If the alarmed detector is on the main egress level elevator lobby, the elevator cabs shall be recalled to the pre-determined alternate recall level.
3. Provide auxiliary contacts within the base of each elevator lobby smoke detector, with each separate landing to be wired back separately to the elevator controller. Coordinate all equipment terminations and sequence of operation with the elevator installer. The use of digital to analog controllers to accomplish this function will be acceptable, if in compliance with codes.

D. The activation of any standpipe water valve tamper switch or sprinkler zone valve tamper switch shall activate a distinctive system supervisory audible signal and illuminate a "Sprinkler Supervisory Tamper Switch" indicator at the system controls (and the remote annunciators). There shall be a distinction in the audible trouble signals between valve tamper switch activation and opens or grounds on fire alarm circuit wiring.

1. Activating the trouble silence switch will silence the supervisory audible signal while maintaining the "Sprinkler Supervisory Tamper" indicator showing the tamper contact is still activated.
2. Restoring the valve to the normal position shall cause the audible signal and visual indicator to pulse at a fixed rate.
3. Activating the trouble silence switch shall silence the supervisory audible signal and restore the system to normal.

E. The alarm activation of any duct mounted smoke detector shall cause the control panel to indicate and report a supervisory trouble only. It shall not sound the general building alarm. It shall initiate an HVAC system shutdown as described above.

F. Include with the control panel, as an auxiliary function, a built-in test mode that, when activated, will cause the following operation sequence:

1. The city connection circuit shall be disconnected.
2. Control relay functions shall be bypassed.
3. The control panel shall show a trouble condition.
4. The panel shall automatically reset itself.
5. Any momentary opening of an initiating or indicating appliance circuit shall cause the audible signals to sound for a minimum of two seconds to indicate the trouble condition.

G. A manual evacuation switch shall be provided to operate the system indicating appliances and/or initiate "Drill" procedures.

H. Activation of an auxiliary bypass switch shall override the automatic functions either selectively or throughout the system and initiate a trouble condition at the control panel.

I. Include any and all detection equipment and interface relays as required to provide a 100% code approved and supervised pre-action Fire Suppression system. Coordinate with the Fire Protection installer as required.

2.2 SUPERVISION

A. The system shall contain Class "B" (Style "B") independently supervised initiation circuits as required for the zoning indicated. Circuits shall be arranged so that a fault in any one zone shall not affect any other zone. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.

B. There shall be supervisory initiation circuit(s), as required, for connection of all sprinkler valve tamper switches. Wiring methods which require any fire alarm initiation circuits to perform this function shall be deemed unacceptable; i.e., sprinkler and standpipe tamper switches (N/C contacts) shall NOT be connected to circuits with fire alarm initiation devices (N/O contacts). These independent initiation circuit(s) shall be each labeled "Sprinkler Supervisory Tamper Switch" and shall differentiate between tamper switch activation and wiring faults. Provide individual annunciation for the main post indicator valve and each tamper switch as indicated by the zoning schedule on the plans or as otherwise required by codes. For these circuits and all exterior underground copper circuit wiring, provide proper surge suppression and protection for circuit.

C. There shall be independently supervised and independently fused indicating appliance circuits as required for alarm audible signals and flashing alarm lamps.

D. All auxiliary manual controls shall be supervised so that all switches must be returned to the normal (automatic) position to clear system trouble.

E. Each independently supervised circuit shall include a discrete (amber color) "Trouble" indicator to indicate disarrangement conditions, per each circuit.

F. The incoming power to the system shall be supervised so that any power failure shall be audibly and visually indicated at the control panel and the annunciator. A green color "power on" indicator shall be displayed continuously while incoming power is present.

G. The system batteries shall be lead-acid type, supervised so that disconnection or failure of a battery shall be audibly and visually indicated at the control panel (and the annunciator).

H. Wiring to a remote annunciator (if provided for system) shall be supervised for open and ground conditions. An independent annunciator trouble indicator shall be activated and an audible trouble signal shall sound at the control panel.

2.3 POWER REQUIREMENTS

A. The control panel shall receive 120 VAC power via a dedicated circuit. The incoming circuit shall have suitable overcurrent protection within the control panel, as well as at the circuit source. If additional circuits are required for this or other control units, they shall be provided by the Contractor.

B. If the facility is equipped with an emergency standby power generator, the fire alarm equipment shall be connected to this system, per N.E.C.

C. The system control panel and auxiliary equipment, such as power supplies shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of time as required by codes for the building occupancy. There shall be reserve battery capacity to drive all alarm appliances for five minute indication at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operating shall be automatic. Batteries, once discharged, shall recharge at a rate that will provide a minimum of 70% capacity in 12 hours, or sooner if required by codes.

D. All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.

E. Power supplies for Notification signals, whether in the main panel or within remote power supply cabinets, shall be designed to provide a minimum of 20% spare capacity for future signals.

2.4 PERIPHERAL DEVICES

A. MANUAL PULL STATION: Manual stations shall be double action and shall be constructed of high impact, red lexan or cast metal with raised white lettering and a smooth high gloss finish. The manual pull station shall have a hinged front with key lock. Stations shall be keyed alike with the fire alarm control panel. When the station is operated, the handle shall lock open in a protruding manner. Furnish one key for each manual station to owner at close of project, during instruction period. Install within 60" of each exit, per code, whether indicated on the drawings or not.

B. CEILING-MOUNTED SMOKE DETECTORS, PHOTOELECTRIC TYPE

1. Furnish and install where indicated on the plans or required, ceiling-mounted smoke detectors. Provide separate outlet-box mounted base with auxiliary relay, or standard base, as required.
2. Smoke Detectors shall be listed to U.L. Standard 268 and shall be compatible with their control equipment. Detectors shall be listed for this purpose by Underwriters' Laboratories, Inc. The detectors shall obtain their operating power from the fire alarm panel supervised detection loop. Loss of the operating voltage shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal to be generated at the control panel. Detectors shall be capable of being reset at the main control panel.
3. No radioactive materials shall be used. Detector construction shall provide mounting base with twist-lock detector head. Contacts between the base and head shall be of the bifurcated type using spring-type, self-cleaning contacts. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control panel. Detector design shall provide full solid state construction, and compatibility with other normally open fire alarm detection loop devices such as heat detectors, pull stations, etc.
4. To minimize nuisance alarms, voltage and RF transient problems, suppression techniques shall be employed as well as a smoke verification circuit and an insect screen. The detector head shall be easily disassembled to facilitate cleaning.
5. Remote LED alarm indicators shall be installed where required.
6. Smoke detectors (and all other system electronics) shall be shielded to protect circuitry from EMI problems generated by power fields, cellular phones, etc.
7. Special Note: The Contractor installing smoke detectors shall use care in the final positioning of all devices. They shall not be installed closer than 36" from an air diffuser or return grille, closer than 24" from a ceiling/wall intersection, or similar location that would diminish detector performance. Refer to and comply with NFPA 72E, "Standard On Automatic Fire Detectors".
8. Provide smoke detector at each fire alarm system control component, as required by code.

C. AUDIBLE UNITS

1. Audible signals shall be delivered by speaker **or horn strobe**. Each audible assembly shall include separate wire leads for in/out wiring for each leg of the associated signal circuit. T-tapping of signal device conductors to signal circuit conductors will not be accepted. Each audible device shall produce a minimum sound pressure level of 92db at 36" on axis. Locate as indicated or required. All audible tones for same function shall be identical, per NFPA. Provide sufficient audible units to comply with code for required coverage and intelligibility. Provide temporal coded signals.
2. Audible units and visual units shall be wired to separate Notification circuits, allowing for silencing of audibles with alarm acknowledgment, continuing operation of strobes until system reset. Addressable devices may be used to fulfill this requirement.

D. VISUAL UNITS

1. Stand-alone visual indicating units shall be xenon type strobe matching audio-visual units. These devices shall be UL listed and be or wall mounted. A high-impact clear lens shall project out from backplate for fire notification. Lettering, if any, shall be oriented upright to the standing viewer. Candela output values of all visual units shall be selected for the covered spaces geometry and size, complying with ADA and NFPA.
2. Provide system-wide synchronization of all visual devices, so that all strobes flash at the same rate and at the same time, complying with ADA.
3. Dual Fire Alert Strobe Devices

    a. The unit shall be complete with a tamper resistant lexan lens with “FIRE” lettering and clear lense for the fire alarm signal. Mount the fire alarm devices on the wall at no less than 80” AFF. “ALERT” lettering shall appear on the amber colored lens of the strobe designated for the emergency alert system. The Alert strobe shall be just above the fire strobe in the same enclosure for new installations. For existing installations install the alert strobe next to the existing fire strobe on the wall surface mounted.
    b. All strobes shall be addressable, ADA approved and capable of a flash at the required synchronized 1 flash per second. Xenon strobe shall provide 4-wire connection to insure properly supervised in/out system connection. Unit shall be complete with all mounting hardware including back box. Audio/visual unit shall be UL listed for its intended purpose. Provide amber lenses for the alert devices.

E. DUCT SMOKE DETECTORS

1. Duct smoke detectors shall be of the solid state photoelectric type, operating on the light scattering photodiode principle. The detectors shall ignore invisible airborne particles or smoke densities that are below the set alarm point. No radioactive materials shall be used. The basic construction of duct smoke detectors shall be the same as that previously described for ceiling-mounted smoke detectors. Duct housing couplings shall be slotted to insure proper alignment of the sampling and exhaust tubes. Detector shall have an alarm status LED visible through a transparent cover, panel or in housing.
2. The Contractor shall furnish air duct smoke detectors with template to the sheetmetal or air handling unit installer for installation. Coordinate length of sampling probe required and furnish appropriate length. Probe tube shall be located in accord with manufacturer's recommendations, to give maximum sampling rate of airflow. Provide multiple detectors, as required, if a single device will not provide adequate sensing due to duct size or air velocity. Wire multiple detectors on a single air handling system as a single zone or address unless otherwise required by prevailing codes. Field verify quantity of detectors needed to provide NFPA-compliant coverage of the air handling unit and provide as required.
3. Detector supervised power and alarm wiring (from F.A. control panel) is to be provided by the Contractor. Interlock wiring from auxiliary contacts to stop or otherwise control air handling unit fan motor(s) is to be provided by the Contractor. Provide auxiliary contacts as required. Zone wiring and indication for air duct smoke detectors shall be maintained separate from area detection devices. Detector shall be capable of being reset at the main control panel, and at a local test/reset station.
4. Where air duct smoke detectors are located in other than Mechanical Rooms or in spaces not easily visible, a remote alarm/power indicating LED key reset station shall be installed. These remotes shall be ganged together, if required, and labeled accurately as to which unit is reporting an alarm condition.
5. Where air duct smoke detectors are indicated to be furnished at concealed air handling units above ceilings or smoke damper locations, furnish as outlined above. Also provide remote indicating alarm LED flush in corridor wall at 7'-0" A.F.F. immediately below installation, or as close as practical to installation. The Contractor is to provide control wiring, E.P. switches, etc., as required to operate smoke dampers, as well as the required operating circuit. Coordinate all requirements with the installer of smoke dampers.
6. Ionization - type detectors shall not be utilized for air duct smoke detection.

7. All air duct smoke detector installations and materials shall be in accord with U.L., NFPA, and any other applicable codes.

F. END OF LINE RESISTOR

1. End-of-line devices (if required) shall be flush-mounted, located at 7'-0" A.F.F. in corridor walls or as indicated.

G. REMOTE POWER SUPPLY UNITS FOR PERIPHERAL

1. Provide remote power supply(ies) as required for proper system operation.
2. Remote power supplies shall be provided with local intelligence compatible with the digital multiplex network, so they have a unique address, providing the ability to monitor the supply for loss of power, shorts, grounds and other supervisory functions.
3. Where required by the fire alarm system manufacturer, remote power supplies shall be provided that will provide sufficient current to drive audio/visual or other required devices.
4. These units shall be located in electrical closets, mechanical rooms or similar spaces. They shall not be installed in finished areas, storage rooms, etc., without the permission of the Engineer. All locations shall be indicated on the shop drawing submissions.
5. Provide dedicated 120 volt power circuit(s) from nearby panelboards as required, whether indicated on the plans or not.

PART 3 - INSTALLATION

3.1 Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be in a completely separate conduit system from power wiring or other raceway systems. Minimum conduit size shall be 3/4" trade size. Maximum wire fill shall be 40%, for any raceway system.

3.2 All junction boxes shall have coverplates painted red and labeled "Fire Alarm". A consistent wiring color code shall be maintained throughout the installation. The number of wiring splices shall be minimized throughout. Excessive wire splicing (as determined by the Engineer), shall be cause for rejection of the work.

3.3 All conductive cabling associated with this system that extends beyond the building envelope shall be provided with surge suppression. Suppression installed shall be approved by the fire alarm equipment manufacturer and in accordance with Division 26 specifications.

3.4 Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate tradesmen or other contractors.

3.5 The Contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of installation.

3.6 The manufacturer's authorized representative shall provide on-site supervision of installation, and shall perform the initial "power-up" of the system after he has thoroughly checked the installation.

3.7 Operation and maintenance manuals submitted for this project shall list names, license numbers, and telephone numbers of at least two installers that are employed full time by the supplier/manufacturer to install and test fire alarm systems in the installation location.

3.8 A floor plan drawing indicating fire alarm devices and wiring only, shall be provided by the manufacturing company for job site use. These drawings shall be approved by the State Fire Marshal's Office or Local Authority Having Jurisdiction, as appropriate and in accord with code requirements. A copy of this drawing shall be submitted to the Engineer for his review, approval and project records.

3.9 WIRING LEGEND

A. CIRCUITS (Unless Otherwise Specified or Required by Equipment) WIRE SIZE-AWG WIRE COLOR EOL Value

ALARM CIRCUITS WIRES Stations Smoke Detectors Heat Detectors Waterflow Switch Tamper Switch-Trouble Only	# 18	ORANGE(pos.) BLUE(negative)	3.3KOHM
TROUBLE CIRCUIT WIRING	# 18	BROWN	
COMMON ANNUNCIATOR WIRES	# 18	VIOLET	
POINT ANNUNCIATOR WIRES	# 18	PINK WITH BRADY TAG	
120VAC WIRING	# 12	BLACK WHITE (Neutral)	
24VDC	# 14	RED (Positive) BLACK (Negative)	
PARALLEL SIGNAL WIRES	# 14	RED (Positive) BLACK (Negative)	15K OHM
SERIES SIGNAL WIRES	# 14	YELLOW	NONE
DOOR HOLDER	# 14	BLUE WHITE (Neutral)	
FAN SHUT DOWN WIRES	# 14	SELECTED BY CONTRACTOR	
ELEVATOR CONTROL WIRES	# 14	SELECTED BY CONTRACTOR	
TELEPHONE WIRES	# 22	TWISTED/SHIELDED	22K OHM
SPEAKER WIRES	# 18	TWISTED	15K OHM

B. Notes:

1. All wire shall be stranded, tinned copper unless otherwise indicated.
2. All shielding is tinned copper braid with additional aluminum sheath unless otherwise noted.
3. All wiring for data lines and risers must be Belden 9574, or an equivalent unless otherwise noted on drawings.

3.10 TESTING

A. Functional Performance Tests: System functional performance testing is part of the Commissioning Process as specified in Section 019113. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Authority.

B. The completed fire alarm system shall be fully tested in accordance with NFPA-72H and NFPA-92B by the contractor in the presence of the Owner's representative and the Local Fire Marshal. Upon completion of a successful test, the Contractor shall certify the test results in writing to the Fire Marshal, Owner, General Contractor, Architect and Engineer. Provide one week's written advance notice of the test to all concerned parties.

C. All auxiliary devices the fire alarm system is connected to, including tamper switches, flow switches, elevator controls, remote receiving stations, etc., shall be fully tested for proper operation where interfacing with the fire alarm system.

D. Demonstrations and Training: Training of the owner’s operation and maintenance personnel is required in cooperation with the Commissioning Authority. The instruction shall be scheduled in coordination with the Commissioning Authority after submission and approval of formal training plans. Refer to Section 019113 and the Commissioning Plan for further contractor training requirements.

E. The Contractor shall provide a minimum of three hours of instructional time to the Owner in the operation and maintenance of all equipment and components. A receipt shall be obtained from the Owner that this has been accomplished, and a copy forwarded to the Engineer. Provide additional training time if required by the Owner at no charge to the contract or as direct charge to the Owner.

3.11 WARRANTY

A. The Contractor shall unconditionally guarantee (except for vandalism or misuse) the completed fire alarm system wiring and equipment to be free from inherent mechanical, software and electrical defects for a period of one year from the date of substantial completion.

B. The equipment manufacturer shall make available to the Owner a maintenance contract proposal to provide a minimum of two inspections and tests per year in compliance with NFPA-72H and NFPA-92B guidelines.

END OF SECTION