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Contract # 296-2017

VOLUME 2
CONTRACT DOCUMENTS
AND
SPECIFICATIONS

DEPARTMENT OF GENERAL SERVICES

FOR

CONSTRUCTION SERVICES FOR FIRE STATION No. 24

Bid No. 95-2017

PREPARED BY:

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ARCHITECTS . ENGINEERS . PLANNERS

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SECTION 210000 - FIRE PROTECTION

1.1 GENERAL

A. The General Conditions, Special Conditions and the applicable portions of Division 1 of the Specifications are a part of this Section.

B. The Contractor for this work shall be governed by any Alternate Bids requested insofar as they affect this work.

C. The building sprinkler system shall be a wet type system. Heads to be pendent, upright and sidewall as required. Provide drains as required.

1.2 SPECIAL REQUIREMENTS

A. No Contractor other than those regularly engaged in the installation of approved and franchised automatic sprinkler systems will be considered or approved for the work under this Section of the specifications. Bidders must have had not less than five years' experience in the fabrication and erection of such systems, and shall have completed installations similar and equal in scope to this system under approval by one or more of the recognized underwriting associations in the insurance field.

B. Before submitting bid, examine all mechanical, electrical, architectural and structural drawings, visit the site and become acquainted with all conditions that may, in any way whatsoever, affect the execution of this work. This bidder shall check with the rating bureau and insuring agency to verify adequacy of water supply for the proposed sprinkler system.

C. The Contractor shall take his own measurements and be responsible for exact size and location of all openings required for installation of this work. Figured dimensions where indicated are reasonably accurate and should govern in setting out work. Detailed method of installation is not indicated. Sprinkler Contractor shall coordinate exact ceiling grid location and install sprinkler heads centered in the 2' x 2' and 2' x 4' ceiling panels. Location of sprinkler head must be carefully coordinated with the Architect.

D. It shall be this Contractor's responsibility to verify all existing water line sizes and to conduct flow test at the existing fire hydrant and report to the Architect results of flow test.

E. It is not the intent of these Plans and Specifications to provide a complete detailed description of the apparatus, materials, equipment, etc., which is required to make a complete installation of a specified fire protection system. Include all required sprinkler heads, tamper flow switches, material and equipment and perform all work required to install a complete and approved installation. The building shall be 100% sprinkled.

F. It shall be this Contractor's responsibility to fully coordinate all required electrical and fire alarm connections with the respective Contractor. Any and all related costs are the responsibility of this Contractor.

G. All existing exterior piping is to remain and be reused, except where indicated on the drawings. Existing fire department connections are to be replaced with new per current fire department standards. See details and notes on the drawings.

H. The installing Contractor shall provide the Owner with three (3) copies of the following (submit IAW shop drawing review standards):

1. Instruction charts describing operation and proper maintenance of sprinkler devices.

2. Published pamphlet on care and maintenance of fire protection systems.

3. All materials and methods shall be in accordance with applicable codes, regulations and/or ordinances and meet approval of local inspection authority and insuring agency having jurisdiction. The latest edition of the National Board of Fire Underwriters Bulletins shall be the minimum requirement for all work. All materials under this Contract shall be listed by the Underwriter's Laboratories, Inc., as approved for fire protection installation. The installation shall comply with the NFPA, and the Kentucky Building Code and Local Fire Marshal in every respect.

I. Perform work under this section in close harmony with other disciplines so completed work shall present a neat and workmanlike installation.

J. Any paving, floors, or other improvements disturbed or destroyed as a result of installation of sprinkler system, shall be repaired or replace to Owner's satisfaction.

1.3 SCOPE OF WORK

A. All work shall be fully coordinated with the architectural phasing plan. The Contractor shall review the drawings and report any conflicts to the engineer prior to bid.

B. Install two (2) new fire hydrants.

C. Installation of new sprinkler system in coordination with new architectural, mechanical, electrical and plumbing work.

D. Furnish all materials, labor, tools, equipment and supervision required for installation of a complete wet pipe sprinkler system for the entire building, including all necessary piping, sprinkler heads, test connections, valves, and drains. Areas to be sprinkled are indicated on Drawings and described hereinafter. (In general, the building shall be 100% sprinkled.)

E. Install guards over sprinkler heads where heads are 7' 0" or less above floor and on other heads where subject to mechanical injury.

F. Work shall commence at the point indicated on the drawings and shall include all necessary accessories and items of work required for a complete and finished wet pipe sprinkler system that provides protection for the entire building (including attic spaces, crawl spaces, concealed spaces, etc.) in compliance with architectural phasing plan. Installation shall include but not be limited to new sprinkler risers; OS & Y valves; fire department pumper connection; and water flow and tamper switches for use by the fire alarm system. Comply with all local water company and fire department requirements. The Contractor shall coordinate the exact location and size of the risers and location of all valves and equipment with the local water company, Fire Marshall, Kentucky Building Code. See detail on drawings. See drawings for locations of fire vault, PIV, detector check valve and domestic water meter.

G. Provide all piping including all valves, sprinkler heads, alarm valves, test valves, control valves and etc.

H. Any apparatus, machinery, material, spares, small items or incidentals not mentioned herein, which may be found necessary to complete or perfect any portion of the installation in a substantial manner, and in compliance with the Architectural Phasing Plan and other requirements stated, implied or intended in these Specifications, shall be furnished without extra cost to the Owner.

I. The building areas in general are based on light hazard occupancy with storage rooms, mechanical rooms and kitchen on ordinary hazard; head spacing as required. A system based on hydraulic calculation, as approved by NFPA 13, is acceptable, and as required by the insuring company. Occupancy hazard shall be confirmed by the Insurance Service Office of Kentucky and the Fire Marshal before calculations are performed.

J. The Fire Protection Contractor shall provide all electrical power and control wiring and interlock which is not shown on the Electrical Drawings to provide a complete system and approved fire protection system.

K. Fire Protection Contractor shall provide temporary heat trace for all piping rated in non-conditioned spaces in order to provide coverage in areas renovated in compliance with Architectural Phasing Plan. Coordinate with Electrical Contractor prior to beginning work.

L. Coordinate all work with Water Company and local Fire Marshal.

1.4 SUBMITTALS

A. The Contractor's attention is directed to the General Conditions and all other Contract Documents of these specifications.

B. Each shop drawing and/or manufacturer's descriptive literature shall have the project name indicated thereon and shall be clearly referenced to the Specifications, Section Number, schedule, material, etc., so the Engineer/Architect may readily determine the particular item the Contractor or Subcontractor proposes to furnish. Each submission shall also contain date submitted. If Shop Drawings and/or other items are transmitted by correspondence, each item of correspondence shall bear the A/E project number.

C. Contractor shall submit shop drawings and data sheets of all major items to be furnished to the Architect/Engineer for approval.

D. Shop drawings and descriptive literature shall be submitted as a minimum, but not limited to the following:

Drawings
Hydraulic Calculations
Sprinkler Heads
Sprinkler Riser
O. S. & Y Valve
Alarm Control
Fire Hydrants
Piping
Pipe Hangers and Support
Tamper Switches
Flow Switches
Alarm Bells
Fire Department Connections
Vault

1.5 PERMITS, CODES AND INSTALLATIONS

A. Obtain and pay for all necessary state, municipal, county, and city permits and taxes which are applicable.

B. Contact the serving Water Company to determine their requirements for piping, hydrants and equipment required to complete the fire protection system.

C. Pay for all fees and costs arising from this installation and for any and all destruction to property, both public and private, which may arise from this project.

D. No work is to be started by the Contractor until Contractor's drawings are approved by the Division of Housing, Building and Construction and the local Fire Marshal's offices, and one copy delivered to the Architect. Entire installation is to be approved by the Insurance Service Office of Kentucky, Division of Housing, Building and Construction, and the local Fire Marshal. Final payment will not be made until these approvals are received.

1.6 RECORD DRAWINGS

A. After all work has been completed, provide for the Architect's records one (1) complete set of as built "Record Drawings" showing final installation of the work.

1.7 PIPE, FITTINGS AND HANGERS

A. Pipe and Pipe Fittings

1. Exterior Water Mains

a. INSTALLATION: All water mains will be installed in compliance with the American Water Works Association specifications and also the water lines will comply with the specifications of the Insurance Services Office of Kentucky and the local water company.

b. TESTS: All water lines shall pass the test of the AWWA specifications and all leaks discovered by this test will be repaired by the contractors. All visible leaks shall be stopped.

c. COVER: All water lines will have a minimum of thirty six inches of cover.

d. PIPES: All water mains shall be ductile iron class 50 pipe, adequate for 150 psi working pressure. Interior of the pipes shall be cement mortar lined with bituminous seal coat. Exterior of the pipe shall receive either coal tar or asphalt base coating. Each piece of pipe shall bear the manufacturer's name or trade mark, the year in which it was produced and the letters, DI or ductile shall appear on the exterior of the pipe. Contractor can use PVC piping (when approved by the local water company) as listed below:

e. GATE VALVES: All gate valves shall be installed with valve boxes and gate valves shall be provided with a two inch square operating nut and shall be opened by turning to the left, counter clockwise. They shall be Mueller or M & H. All valves and connection must comply with local water company requirements. See details on drawings.

f. New piping and valves must meet requirements of the Water Company.

2. Fire Hydrants

a. All fire hydrants shall be 5 1/4" traffic model with two 2 1/2" hose connections and one 4 1/2" pumper connection and shall be either Mueller or M & H. All hydrants are to be installed with a gate valve and valve box and connected with mechanical joint anchor pipe. Hydrants shall be located in conformity with the requirements of the local fire department. See detail on drawings. **Note: Confirm all**

hydrant manufacturers, types, hose and pumper connections with the local water company and the local fire department prior to ordering.

b. After substantial completion but before final completion, contractor shall conduct, or obtain a two-hydrant flow test per NFPA requirements, and provide results to the owner, architect, and engineer.

c. Paint all new fire hydrants per water company and/or fire department requirements. In the absence of water company or fire department requirements, paint fire hydrants per NFPA requirements to identify capacity of hydrant.

B. Pipe used overhead

a. New piping and valves must meet requirements of the Water Company.

2. Interior overhead piping shall be wrought steel and must comply with the specifications of the ASTM as listed in NFPA 13, 3 1.1 Piping. Piping 2" and smaller shall be Schedule 40; piping 2½" and larger may be Schedule 40 or Schedule 10. Interior pipe fittings and couplings shall be manufactured by Reliable.

3. Dimensions for all overhead pipe must be in accordance with the American Standard for Wrought Steel and Wrought Iron Pipe, ASA No. B 36, 10 70 for pressures up to 300 psi is permitted.

4. Flexible sprinkler head runouts can be used at Contractor's option where approved by NFPA 13.

C. Hangers

1. Furnish and install all hangers of approved pattern and size per NFPA to support all pipes in a substantial manner.

2. Hangers for overhead piping shall comply with NBFU requirements as to size and spacing. Special and improvised supports and hangers shall meet with the approval of the Underwriters' Laboratories and the Architect.

1.8 IDENTIFICATION

A. This Contractor shall furnish and install metal signs identifying valves, drains, etc., as required. Signs shall be secured with approved ball chain.

1.9 DRAINS

A. Where drains, flushing connections, etc., are necessary to comply with local code or NBFU requirements, they shall be considered a part of this Contract and furnished and installed accordingly, whether shown specifically on the Drawings or covered in these Specifications.

B. All sprinkler branch piping shall be installed to drain at main riser wherever possible.

C. Where sprinkler piping is trapped, an approved auxiliary drawoff shall be provided and installed. Provide all test drains as required. All exposed piping on the exterior of the building shall be rust proofed and painted, color as selected by Architect. Provide splash blocks at all exterior drains.

1.10 VALVES

A. Control Valves

1. All valves 2 inches and smaller shall be bronze, solid bronze solid wedge disc, screwed pattern, rising stem, designed for 150 psi working pressure and approved by Underwriters' Laboratories and Factory Mutual.

2. All valves 2 1/2 inches and larger shall be iron body, bronze mounted, double disc, parallel seats, outside screw and yoke, and screwed or flanged pattern designed for 175 psi working pressure and approved by Underwriters' Laboratories.

B. Check Valves

1. Check valves shall be iron body, bronze mounted, screwed or flanged and Underwriters' and Factory Mutual approved for 175 lbs. working pressure. Detector check valves, with bypass meter, must meet the requirement of local water company and Fire Marshal.

C. Alarm Valves and Flow Indicators

1. Alarm valve shall be of variable pressure type, designed to prevent false alarms due to water hammer or other pressure surges, and shall be of Underwriters' approved type.

2. Provide all valves, gauges and other accessories needed to make a complete installation.

3. Wiring and connection shown on Division 23 drawings shall be provided by the electrical contractor. All other wiring shall be provided by the sprinkler contractor.

D. Backflow Preventer

1. Backflow preventer shall be Ames Series 3000SS double check valve detector assembly. Equivalent manufacturers Febco, Wilkins, Watts or equal.

E. Gate Valves: All gate valves shall be installed with valve boxes and gate valves shall be provided with a two inch square operating nut and shall be opened by turning to the left, counter clockwise. They shall be Mueller or M & H. All valves and connection must comply with local water company requirements. See details on drawings.

1.11 SPRINKLER HEADS AND CABINET

A. All sprinklers shall be Underwriters' Laboratories approved automatic spray sprinklers of correct temperature and type.

B. The Contractor shall furnish and install in an approved metal cabinet with four (4) replacement heads of each type as required by the National Board of Fire Underwriters.

C. Sprinklers shall be Reliable, Viking, Star, Grinnell, or equivalent. Sprinkler heads in classrooms, toilets, cafeteria and media center shall be fully recessed, pop-down type with covers. The remainder of ceilings shall have semi-recessed type heads. Side wall sprinkler heads shall be semi recessed type, with chrome plated finish with escutcheon. (Color as selected by Architect). Upright sprinkler heads in unfinished areas shall be plain brass or bronze finish. Orifice size to be selected by Contractor according to available water pressure and head spacing.

D. Heads shall not be painted; cover and protect during any painting operations in area.

1.12 FIRE DEPARTMENT CONNECTIONS

A. Furnish and install for the building one brass type fire department connection with proper threads to fit local fire department hose connection, connected to the system as required, with necessary check valve and ball drip drain connection as required. Coordinate exact location and sizes with local water company and Fire Marshal.

1.13 PAINTING AND SIGNS

A. Painting

1. All painting of sprinkler piping and equipment, except sprinkler heads, shall be performed under Division 9, Finishes; unless otherwise noted. Painting colors shall be according to the color coding chart hereinafter specified. All stenciled markers and arrows shall be provided under this Division of the Specifications after piping has been painted.

2. The following shall be painted: all equipment and metal surfaces which are not factory finished in high grade machinery enamel on all damaged or rusted surfaces; all exposed piping in all areas.

3. All piping shall be painted and stenciled according to the following chart:

PIPE	PIPE COLOR CODE	ABBREVIATION
Fire Protection Piping	Bright Red	F

4. Markers and arrows shall be painted on the piping using machine cut stencils. All letters shall be sprayed using fast drying black lacquer paint. On pipe sizes 3" and over, letters and arrows shall be 2" in height. On pipe sizes smaller than 3" letters shall be 1" in height. All markers and arrows shall be properly oriented so that descriptive name may be easily read from the floor.

5. Piping, whether exposed or concealed, shall be marked not less than every 20 linear feet or in every room; whichever is greater, and at the point where the piping passes through walls or floors.

1.14 INSPECTOR'S TESTS

A. Install a 1" inspection test connection. Discharge from test connections shall run to open air. All locations must comply with Fire Marshal requirements.

B. Inspection test connection to control valve shall be located not over 7' above floor.

C. Inspection test connection shall have an attached metal tag bearing the words "Test Connection".

1.15 TESTING FLUSHING AND CLEANING

A. Furnish all labor, equipment, and conduct all required tests in the presence of the Owner and Architect/Engineer or designated representative.

B. All piping and devices comprising the fire protection system shall be tested under hydrostatic pressure of not less than 200 psi and maintained for not less than 2 hours in accordance with the NFPA 13, and leakage shall not exceed quantities indicated.

C. Any leaks or cracks developing as a result of these tests shall be repaired to the satisfaction of the Owner.

D. The Owner and Architect/Engineer or designated representative shall be notified three days in advance of any tests.

E. Upon satisfactory completion of the the test, a written approval, signed by the Architect/Engineer shall be given to the Contractor. This written approval, however, does not relieve the Contractor of responsibility for any failure during the period of the guarantee.

F. All underground piping shall be thoroughly flushed in accordance with the requirements of NFPA 13, and flush test must be witnessed by proper authority.

G. Upon completion of this work, all debris, materials, and equipment shall be removed from the building and premises; all piping shall be cleaned ready for painting when installed.

1.16 CUTTING, PATCHING AND WELDING

A. Be responsible for cutting, patching and welding all openings required in walls, floors, ceilings or roof for all materials and equipment furnished under this Section of the Specifications.

B. Sleeves or openings shall be left in all new construction for passage of pipes and/or ducts. Where openings or sleeves have been omitted, they shall be drilled or sawed as required by the Architect. All cutting and patching shall be done by the trades whose work is affected. All expenses incurred shall be a responsibility of this Section of the Specifications.

C. Welding is at option to the Contractor; unless otherwise specified.

1.17 EXCAVATING AND BACKFILLING

A. This Contractor shall perform all excavation, including necessary shoring, and all backfilling required for the completion of work under this Contract that is to be installed underground, outside, or within building walls.

1.18 CHANGES

A. The Contractor shall make no changes in installation from layout as shown on approved working drawings which may be requested by any Inspection Bureau or Insurance Association unless such change is specifically approved by the Architect. Any changes made other than as above stated are at the Contractor's own expense and responsibility.

1.19 LEAK DAMAGE AND GUARANTEE

A. This Contractor shall be responsible during the installation and testing periods of the sprinkler systems for any damage to the buildings, their contents, etc., due to leaks, or by overflow; and shall pay for necessary replacements or repairs to the building, equipment, or stored materials damaged by such leakage.

B. At the completion of the work under this Sprinkler Contract the Contractor shall furnish, in writing, to the Architect a guarantee stating that all equipment, materials, and work performed are in full accordance with the Plans and Specifications and all authorities having jurisdiction.

C. The Contractor shall also furnish to the Architect a written guarantee (in triplicate) that all equipment, materials, and work performed under this Contract, and any subsequent Change Orders thereto, are fully guaranteed for one (1) year from date of substantial completion and that any equipment, material, or workmanship which may prove defective within that time will be replaced at no cost to the Owner.

1.20 OPERATION AND MAINTENANCE INSTRUCTIONS

A. At the completion of the work specified above, the Sprinkler Contractor shall provide a small scale plan of the building indicating the locations of all control valves, low point drains, and Inspector's test. The plans shall be neatly adjacent to the sprinkler riser or header, or as directed by the Engineer.

B. The Contractor shall furnish three (3) sets of printed operating and maintenance instructions to the Owner, and adequately instruct the Owner's maintenance personnel in the proper operation of all sprinkler devices installed. See Section 15001 for a complete description of manual requirements.

END OF SECTION 210000

SECTION 220100 - PLUMBING GENERAL PROVISIONS

1.1 GENERAL

A. The General Conditions and Special Conditions and all other Contract Documents shall apply to this Division of the work as well as to all other Divisions.

1.2 SCOPE

A. All work shall be fully coordinated with the architectural phasing plan. The Contractor shall review the drawings and report any conflicts to the engineer prior to bid.

B. This branch of the work includes coordination with all utility companies; providing utility meters; utility tap on fees; agency review fees and all inspection fees; all labor, materials, tools, excavation and backfill and all equipment necessary for the installation of Fire Protection and Plumbing Systems as shown on the Drawings and Specifications and/or as required for complete and operating systems. The work shall include starting, balancing and the necessary and required tests to insure the proper operation of the complete system.

C. A complete and operating plumbing system shall be provided. See plans for diagrams and details. Domestic hot water shall be provided with electric water heaters in mechanical rooms. All piping, valves, pumps, heat exchangers and associated materials connected into domestic water system shall be copper, bronze, or stainless steel.

D. The building shall be 100% sprinkled (refer to Section 210000).

E. All work for this project must comply and be in strict accordance with the Kentucky Building Code, Kentucky Plumbing Code, Kentucky Boiler Code, NFPA, ADA, NEC and all local codes and regulations.

F. In general (as a minimum) all materials and equipment must be installed in strict accordance with manufacturer's requirements; and provided with all required controls, internal fusing, relays, piping connections, electrical connections, ductwork connections, etc., to provide for complete and operable systems.

1.3 PERMITS, CODES, AND APPROVALS

A. Permits and Fees

1. All permits, tap on fees and agency review and inspection fees necessary for the complete Fire Protection and Plumbing systems shall be obtained by the Contractor from the authorities governing such work. The cost of all permits shall be borne by the Contractor.

B. Codes

1. The minimum standard for all plumbing work shall be the requirements of the Kentucky State Plumbing Law, Regulation and Code, Kentucky Building Code, ADA, The Division of Water Quality and local ordinances. All plumbing and fire protection for this project must as a minimum comply and be in strict accordance with the Kentucky Building Code, Kentucky Plumbing Code, Kentucky Boiler Code, NFPA, ADA, NEC, The Division of Water Quality and the "Standards of Safety" of the Commonwealth of Kentucky.

C. Approvals

1. All work must be approved by the Architect/Engineer, Owner and all related Code Agencies before final payment will be made.

2. As a minimum, the following approval Certificates of Inspection and Approval shall be required:
   a. Plumbing Inspection
   b. Fire Protection Inspection
   c. Health Department Inspection
   d. Electrical Inspection
   e. Local and State Building Inspections.
3. Final payment will be contingent upon receiving all Approval Certificates.

1.4 PLUMBING DRAWINGS AND SPECIFICATIONS

A. The Drawings and Specifications are intended to cover all work enumerated under the respective headings. The Drawings are diagrammatic only as far as final location of pipes, ducts relative size, etc., is concerned. Any item of work not clearly included, specified and/or shown, errors or conflict between Plans (Mechanical, Architectural, Structural or Electrical), Specifications, codes and field conditions, shall be clarified by a written request to the Architect by the Bidder before bidding; otherwise, the bidder shall, at his own expense, supply the proper labor and materials to include these items of work and to make good any damages or defects in his work caused by such error, omission or conflict. Under no circumstances shall a Contractor scale the Drawings for the location of equipment and work.

B. Piping schematics, risers, motors and details shown on the Drawings are for the equipment specified hereinafter. All revisions, modifications or changes in piping, accessories etc., due to using equipment of a different manufacturer than specified hereinafter, shall be the responsibility of the bidder and shall be made at no additional cost to the Owner. All modifications or changes shall be submitted to the Architect in writing and meet with his approval before the equipment is released for shipment.

C. The Contractor shall be responsible for all revisions, modifications or changes necessary in the structural, architectural or electrical drawings and/or work to accommodate the equipment to be furnished under this section of the Specifications. This shall be made at no additional cost to the Owner.

D. Plumbing as built "Record Drawings" shall be kept up to date each day. "Record Drawings" shall be reviewed by Architect/Engineer each month with contractor's pay request review.

E. Any deviation in work as shown on plans and specifications must be approved in writing by Architect/Engineer prior to installation.

1.5 MATERIAL AND WORKMANSHIP

A. Material and workmanship shall comply with the General Conditions of these Specifications.

B. All material and equipment and locations of same shall at least conform with the standards of the Underwriters' Laboratories, Inc., whenever applicable.

1.6 ACCESSIBILITY

A. All equipment, valves, motors, damper operators, traps, unions and all other items which require adjustment, maintenance, repair and observation shall be installed in such a fashion that such maintenance, repair and observation can be readily achieved without

undue difficulty including complete removal of heat pump units. Where the drawings show these items in locations not conforming to the above, the Contractor shall advise the Architect/Engineer of this conflict prior to bid Date otherwise he shall, at his own expense, relocate such items as directed by the Architect/Engineer. Where such items are installed above inaccessible ceilings or in or behind walls, this contractor shall provide approved access panels unless otherwise directed in these Specifications.

1.7 ARCHITECTURAL DRAWINGS AND SPECIFICATIONS

A. Each Contractor shall refer to the Architectural and Structural Drawings and Specifications for the general construction of the building, for floor and ceiling heights, for location of walls, partitions, beams etc., and shall be guided accordingly for the setting of all sleeves and equipment.

B. Under no circumstances shall a Contractor scale the Drawings for the locations of equipment and work.

1.8 COOPERATION WITH OTHER CONTRACTORS

A. Each Contractor shall demand and examine all Drawings and Specifications pertaining to the construction before installing the work described and shown under these Drawings and Specifications. Each Contractor shall cooperate with all other contractors in locating piping, openings, chases and equipment in order to avoid conflict with any other contractor's work. It is the responsibility of all trades to examine all shop drawings of other trades that would require equipment to occupy the same space and plane within the building to eliminate any potential conflicts. No extra payment will be allowed for relocation of piping, ductwork, and equipment not installed in accordance with the above instructions, and which interferes with work and equipment of other contractors.

1.9 INSTALLATION OF EQUIPMENT

A. All appliances, materials and equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations. All auxiliary piping, special controls, water seals, valves, electrical connections, drains, etc., recommended by the manufacturer, required for proper operation, or required by code shall be furnished and installed complete.

B. All equipment designed and constructed for indoor use shall not be shipped to the site until such time that the equipment is ready for permanent installation in a dry building or may be stored on site provided equipment is stored in a water and moisture tight storage building or job trailer. Covering equipment outdoors with plastic or tarp is not acceptable.

1.10 PROTECTION

A. No piping shall be installed in any part of the building where danger of freezing may exist without adequate protection being given, whether or not insulation is specified for the particular piping. All damage resulting from leaking pipes shall be borne by the Contractor under this Division.

B. All work, equipment and materials shall be protected at all times. All pipe openings shall be closed with caps or plugs during construction. All equipment and accessories shall be tightly covered and protected against dirt, water or other injury during the period of construction.

C. Before the building is turned over to the Owner all of the equipment must be carefully cleaned of debris and dust, coils cleaned and flushed out, new filters installed, and all ductwork cleaned of debris and dust.

1.11 OPENINGS AND ESCUTCHEONS

A. The Contractor under this Division shall be responsible for the openings he may require in floors, walls or ceilings of any type construction whether or not shown on the Architectural and/or Structural Drawings.

B. Openings that have been shown on the Architectural and/or Structural Drawings will be provided under other Divisions; however, the responsibility for the correct size and location of such openings shall be that of the Contractor under this Division.

C. Openings that have not been shown on the Architectural and/or Structural Drawings shall be provided by the Contractor under this Division as follows:

1. Passages for pipe through masonry and concrete walls and floors shall be by means of standard weight steel pipe sleeves. With the approval of the Architect, holes may be cut and sleeves may be omitted in areas having thin or lightweight construction. Holes shall be cut by means of rotating drill bits or saws, producing a neat and accurate fit for the pipes. No hammer devices will be permitted. Such holes shall be not more than one half inch (1/2") greater in diameter than the external diameter of the pipe. Cutting of holes in structural slabs or members will not be permitted without approval of the Architect/Engineer.

2. Openings for insulated piping such as heating, domestic hot and cold water, etc., shall be of sufficient size to allow the insulation to pass through uninterrupted with the piping.

3. Cast iron sleeves shall be installed through walls where pipes enter the building below grade and at all fire rated assemblies. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking with lead and oakum between pipe and sleeve for waterproofing.

4. Openings for ductwork fixtures, equipment, etc., through floors, walls or ceilings, shall be located and sized by the Contractor under this Division who shall provide and set necessary sleeves or sheet metal forms for all such openings through concrete walls, floors or the roof slab. For openings required through ceilings, walls or roof construction, the Contractor under this Division shall furnish and install all necessary frames, supports, lintels, etc., required for the openings, such as plaster frames for registers and recessed equipment frames.

D. Smoke and Firestopping

1. Shall be provided between ductwork and its opening through all walls, floors and partitions. Firestopping shall be provided between sleeves and piping which pass through walls, floors or partitions. This contractor shall furnish and install fire protection sealant where pipes pass through fire rated walls, partitions, ceilings or floors. The fire rated integrity of the assemblies must be maintained.

2. The materials used shall be UL 263 and UL 1479 classified and meet ASTM E814 standards and be rated for assemblies where applied. Material shall be

installed in strict accordance with manufacturer's recommendations and published literature.

3. Furnish and install 3M "Interam Fire Protection Systems", DOW CORNING or Hilti "Fire Stop" System.

E. All exposed piping passing through floors, ceilings and walls in finished areas shall be fitted with a chrome plated escutcheon of sufficient outside diameter to amply cover the sleeved opening and an inside diameter to closely fit the pipe around which it is installed.

F. Galvanized sheet metal collars shall be provided around all ducts, equipment, etc., exposed in finished areas. Where such openings are finished and the space around the unit is small, the collar may be omitted with the approval of the Architect.

1.12 CUTTING AND PATCHING

A. No cutting and patching of new finished work will be permitted without the approval of the Architect, and such work shall be done only under his direction. Coordinate all openings with Architectural specifications.

B. All work improperly done or not done at all, as required in preceding article "Openings and Escutcheons", will be performed as directed by the Architect/Engineer and at the expense of the Contractor whose work is affected.

1.13 SERVICE AND GUARANTEE

A. Contractor shall be responsible for guaranteeing all work, including equipment, materials and workmanship furnished under this section of the Specifications.

B. The warranty created by Article 3.5 of the General Conditions remains enforceable throughout the period of the Kentucky statute of limitations. The Warranty is different from the one-year correction period defined in General Conditions Article 12.2.2. except for items of equipment requiring explicit extended warranties, refer the Bidder/Contractor to General Conditions Articles 3.5 and 12.2.2 for warranty and correction of work.

C. Any defective work, equipment, materials and/or workmanship that develops within the guarantee period, which is not caused by ordinary wear, damage or abuse by others, shall be replaced and/or corrected without additional cost to the Owner.

D. Make a minimum of two (2) service calls during guarantee period, free of charge, to check with Owner and to check and repair malfunctioning equipment which was installed. Service calls shall be in middle and end of guarantee period and as required to maintain systems operation. Dates shall be listed in operating and maintenance manuals, along with contractor's name and phone number.

1.14 SHOP DRAWINGS

A. Each Shop Drawing and/or manufacturer's descriptive literature shall have the project name indicated thereon and shall be clearly referenced to the specification, section number, schedule, material, etc., so the Engineer may readily determine the particular item the Contractor or subcontractor proposes to furnish. Each submission shall also contain Date Submitted. If Shop Drawings and/or other items are transmitted by correspondence, each item of correspondence shall bear project name. (The shop drawings shall be submitted in ACCO Model 25071 Series binders with Presstex covers). At the Engineer's discretion, the Contractor shall submit additional shop drawings as deemed necessary.

B. The Plumbing Contractor must carefully review and stamp all shop drawings before submitting to Architect/Engineer. The Contractor must verify all quantities, sizes, left and right-hand connections, access door locations, horsepower, voltage, insure adequate clearance for installation and service, etc.

C. The Plumbing Contractor must coordinate all submittals with the Electrical Contractor to insure proper clearances with electrical equipment and to insure that all equipment with electrical connections are being submitted with proper voltage, proper left and right-hand electrical connections, proper relays, proper contactors, proper starters, etc.

D. Descriptive literature and schedules shall be submitted as a minimum (but not limited to) the following:

Plumbing Fixtures & Trim	Drainage Specialties	Oil/Water Separators
Water Heaters	Pumps	Domestic Water Piping
Expansion Tanks	Manholes	(Exterior & Interior)
Water Supply Specialties	Sprinkler System	Sanitary DWV Piping
Tempering Valves	Insulation	(Exterior & Interior)

1.15 CLEANING

A. After the Architect/Engineer has completed examination, this Contractor shall remove all stickers, tags, etc., and shall thoroughly clean all equipment, fixtures, and materials installed under his section of the work.

B. Surplus material, rubbish and equipment resulting from the work shall be removed from the building and premises by the Contractor upon completion of the work in accordance with the General Conditions.

C. All equipment shall be thoroughly cleaned to "Factory New" condition prior to turning over to owner. Touch up or completely repaint equipment as required.

1.16 EXAMINATION OF SITE

A. Bidders shall visit the site before submitting proposals to satisfy themselves as to the nature and scope of the work and any difficulties attending to the execution.

B. The submission of a proposal will be construed as evidence that such an examination has been made. Later claims for labor, equipment, materials, etc., required for difficulties encountered which could have been foreseen had such an examination been made, will not be recognized.

1.17 PAINTING

A. All exposed interior and exterior piping, ductwork and equipment not prefinished by equipment manufacturer or new equipment or items installed under this division shall be thoroughly cleaned and readied for painting. Painting shall be provided under the general contract. Consult painting contractor for special surface preparations that may be required. See other paragraphs contained herein for pipe color coding for "Piping Identification".

1.18 SINGULAR NUMBER

A. In all cases where a device or piece of equipment is referred to in the singular number (such as grille, lavatory, etc.), it is intended that such reference shall apply to as many such items as are required to complete the installation.

1.19 CONCEALMENT OF PIPING AND DUCTWORK

A. In general, furred ceilings and joist spaces are provided in parts of the building to conceal horizontal piping and ductwork. Vertical risers serving downfeed heating and air conditioning units shall be installed concealed, unless shown otherwise on the Drawings.

B. In the Mechanical Room, attic and areas without ceilings and similar unfinished areas, piping and ductwork shall be installed exposed.

C. All work installed exposed shall be installed neatly to insure a pleasing final appearance. Vertical piping shall be perfectly plumbed.

D. Particular care shall be exercised in the location of ceiling diffusers and outlets to avoid conflict with the work of other Divisions. Surface units in the Ceiling shall fit into the acoustical ceiling suspension system and shall, in general, be symmetrical with the light fixtures.

E. Refer to the Architectural Room Finish Schedules for the areas having suspended ceilings and install the work accordingly.

1.20 CONCRETE WORK AND ANCHOR BOLTS

A. The Contractor under this Division shall provide all concrete bases, curbs and pads for all floor and ground mounted equipment unless otherwise indicated.

B. The Contractor under this Division shall verify the sizes and locations of all supports, bases and pads prior to pouring of same to be certain that the installed units will be compatible.

C. The Contractor under this Division shall set anchor bolts for the equipment prior to pouring of concrete. Sizes and exact locations of bolts shall be determined by the manufacturer's recommendations for the equipment served.

D. Concrete work must be provided in strict accordance with Section 03310 Concrete Work As a minimum provide pads using 3500 psi concrete reinforced with WI.4 x WI.4 welded wire fabric. Chamfer top and edge corners with 3/4" preformed chamfer strips. Slope top to floor drain if drain is provided in pad.

1.21 WORK AND EQUIPMENT UNDER OTHER DIVISIONS

A. The Contractor under Division 23 will provide all power wiring and conduit and install and connect each item of electrical equipment furnished under this Division unless specified otherwise. He will also provide starting equipment for motors not specified to have starting equipment furnished under this Division.

B. The Contractor under other Divisions will provide the following:

1. Painting of all mechanical work throughout.
2. Electrical work as noted in Paragraph (A) above.
3. Furnish and install all access doors shown on the Architectural Drawings.

1.22 FLASHINGS

A. The Contractor under this Division shall furnish and install all required flashing necessary for ducts, piping, fans, equipment, etc., which rest on or pass through the exterior walls and roof to insure a watertight installation. All penetrations shall be in strict accordance with Architects instructions. Verify prior to construction. Coordinate all roof flashing materials and procedures with Roofing Contractor.

B. Flashings for plumbing vents and drains shall be sheet lead weighing no less than 3 pounds per square foot or as required by Architect/Engineer and roofing manufacturer.

C. Flashings for all equipment must be in strict accordance with Architect/Engineer and roofing manufacturer's requirements.

1.23 VALVE TAGS AND CHARTS

A. The Contractor under this Division shall attach a numbered brass tag to each valve installed under this Contract. Each number shall be prefixed with the letter "H" for heating valves and "P" for plumbing valves. Tags shall be attached to the valves by means of brass "S" hooks. Tags shall be Seton Name Plate Co., C.H. Hanson Co. or Identifications.

B. A chart headed ""PLUMBING VALVE CHART" shall be prepared. Three original charts shall be prepared and approved by the engineer. One of each approved type chart shall be framed under glass and mounted on the wall in the main mechanical room where directed. Three photocopies of each chart shall be made and shall be submitted through normal shop drawing channels for approval and subsequent owner's files. Each chart shall be formatted as shown below: (All normally closed valves shall have a brass tag marked Normally Closed.)

PLUMBING VALVE CHART
PROJECT NAME
DATE

TAG NO.	VALVE LOCATION	VALVE TYPE/SIZE	VALVE FUNCTION

1.24 WIRING DIAGRAMS

A. The Contractor under this Division shall submit complete wiring diagrams to the Architect/Engineer for approval. Wiring diagrams shall show all electrical connections for air conditioning units, starters, switches, motors, controls, etc.

B. Standard wiring diagrams of manufacturer's equipment will not be acceptable for this project unless they are altered to agree with the project requirements. Wiring diagrams shall include all interlocks with other equipment, whether furnished by the manufacturer or not.

C. After review by the Architect/Engineer, a copy of the wiring diagrams shall be given to the Contractor under Division 23.

D. Unless specified otherwise, power supply wiring to power connections on equipment will be provided by the Contractor under Division 26. The Contractors under Division 23 shall be responsible for the control wiring and correct sequence of operation of all mechanical equipment after all wiring has been completed. Control wiring shall include wire, conduit and miscellaneous materials required for connecting control devices. The Control Contractor shall provide power wiring and connections to control equipment if this required power wiring is not shown on the Electrical Drawings and Specifications.

1.25 ACCESS PANELS

A. Access panels shown on the Architectural Drawings will be furnished and installed under Division 8. In addition, the Contractor under this Division shall furnish all other access panels whether shown or not that are needed for access to trap primers, open receptacles, valves, vents, fire dampers, heat pump units, etc., in inaccessible locations installed under this Division of the work.

B. Access panels shall have a minimum size of 12" x 12" and shall be centered beneath equipment for accessibility and maintenance. Access panels must be of adequate size to service, observe, remove and maintain equipment.

C. Access panels shall be equal to the types specified under the Architectural Specifications. As a minimum the access panels shall be equivalent to Cesco Products style FB/FB SS, Besco, Inryco/Milcor, Phillips or equivalent, 14 gauge with vandal proof lock and frame as selected by Architect.

D. Ceiling Types

1. In areas with suspended acoustical tile ceilings (installed on exposed metal grid suspension system so that the tile may be readily removed), equipment, valves, etc., install above these ceilings will be considered to be accessible. Metal grid must be installed at heat pumps in such a manner as to be removable for removal of heat pump units.

2. All plastered ceilings or ceilings having concealed spline type of suspension system will be considered as not removable for accessibility to equipment; therefore, access panels will be required.

3. See Architectural Drawings and Specifications for the types of ceilings throughout the building.

1.26 EQUIPMENT DRAINS

A. Provide a drain line from each item of equipment requiring a drain (cooling coil drain pans, pumps, backflow preventers, heat pumps, etc.) to the nearest floor drain, roof drain, open receptacle, to outside of the building, or as shown.

B. Drains from units shall be trapped to provide easy water flow through the drain line. Install in strict accordance with manufacturer's recommendations.

1.27 EQUIPMENT IDENTIFICATION

A. Furnish and install on each item of equipment, such as pumps, water heaters etc., a nameplate giving its name and function.

B. Nameplates shall be engraved bakelite (white letters on black background and shall be equal to Seton Nameplate Co., C.H. Hanson Co., or Identifications.

C. All names and numbers for equipment and rooms shall be approved by the Architect before nameplates are prepared so that correct identification will be used.

1.28 UNDERGROUND UTILITIES TRACE TAPE

A. Install in open trench approximately 14" above pipe, (but no more than 24" below finished grade), 2" wide trace tape to indicate location of utility line. Tape shall be manufactured to be traceable with pipe detector above finish grade. Tape shall be bright yellow in color and stamped with the system name at regular intervals. The tape shall be Terr Tape as manufactured by Griffolyn Co.; C. I. Thornburg, Seton Co., Bradey Co. or Craftmark.

B. Tracer tape, similar to tape specified above shall be provided over sanitary sewer marked "Sanitary Sewer", storm sewers marked "Storm Sewers", domestic water marked “Water” and fire protection marked “Fire”.

C. In addition to trace tape noted above provide #10 copper tracer wire above all underground utilities.

1.29 OPERATIONAL INSTRUCTIONS

A. Furnish services of a fully competent operational instructor for a total of two (2) one day sessions days, unless otherwise specified, as directed by Architect/Engineer to instruct operating personnel in operations and care of all equipment and systems (including control systems) and their various components.

1.30 CONNECTIONS TO EQUIPMENT SPECIFIED IN OTHER SECTIONS

A. Examine all Contract Documents and be thoroughly familiar with all items of equipment in other sections or by Owner, unless otherwise specified or indicated on Drawings. Rough-in for and make final connections to all equipment which requires any of the services specified in this Section and including furnishing and install all valves, P-traps, unions, vacuum breakers and all other specialties as required to make all work and equipment final and operating. It is the intent of the Contract Drawings to detail and indicate all such equipment; however, be responsible for notifying Architect/Engineer in writing of major discrepancies seven (7) days prior to Bid Date; otherwise, all such connections shall be made at no extra cost.

B. Unless specified otherwise, all conduit, wiring and connections for power to mechanical equipment will be provided by Electrical Contractor. Be responsible for correct sequences of operation of all mechanical equipment after all wiring has been completed.

1.31 PLATFORMS AND SUPPORTING STANDS

A. Provide each piece of equipment or apparatus suspended from ceiling or mounted above floor level with suitable structural support, pipe stand, platform or carrier in accordance with best recognized practice, as approved by Architect/Engineer as indicated on Drawings. Such supporting or mounting means shall be provided by each Contractor for all equipment furnished by him, unless otherwise specified. Exercise extreme care that structural members of building are not overloaded by such equipment. Submit shop drawings on prefabricated or field erected equipment supports not detailed on Drawings.

1.32 EXPANSION COMPENSATORS

A. Erect piping to provide for expansion and contraction without harmful strain to building structural members, pipe and vibrating equipment. Provide expansion bends or devices other than those indicated, if, in Architect's/Engineer's opinion, such devices are required by field conditions. Unless indicated otherwise, expansion bends are preferred to use of expansion joints and shall not be substituted without Architect's/Engineers written permission.

1.33 VIBRATION AND SOUND CONTROL

A. Be responsible for unnecessary or undue vibration or sound transmitted throughout building due to negligence of improper installation of material and equipment and be responsible for correction of such conditions.

1.34 CLEANING OF PIPING AND EQUIPMENT

A. Install and maintain pipe and equipment which is clean and free of dust, dirt and scale. Where roughed in only, provide temporary air-tight covers at all pipe, duct and equipment openings. Provide protection from elements.

B. Upon completion of work, thoroughly clean and lubricate all equipment; clean and flush all piping as often as necessary to satisfy Architect/Engineer and Owner that system is clear of oil, dirt, scale or other foreign matter; clean all strainers after flushing operation and prior to balancing;

C. Keep all nameplates on equipment clean and exposed for easy reading.

1.35 WRENCHES - TOOLS

A. Furnish special wrenches or tools necessary to dismantle or service equipment or appliances installed. Wrenches shall include necessary keys, handles and operators for valves, cocks and hydrants. Number of wrenches furnished in proportion to devices installed shall be on a 50% basis, but not less than two (2) of each type shall be provided. All wrenches shall be neatly mounted on a three-quarter inch plywood panel properly marked with laminated plastic plates. Panel shall be fastened to wall where designated by Architect/Engineer.

1.36 UTILITY SERVICE MARKERS

A. Provide markers for underground utility service at a minimum of 200' increments and at each change in direction to define route of utility not already marked of hydrants, valves, poles or other visible surface features.

B. Markers shall consist of bronze plates, ground and polished, and marked to identify service. Markers shall be stamped with arrows indicating direction service extends.

C. Markers locating services at building shall be installed in masonry for concrete walls, approximately two feet above ground. Markers locating service elsewhere on site shall be installed in 6" x 6" x 2"-0" deep concrete bases. Coordinate all work with Architect/Engineer.

1.37 TESTS

A. See Section 220300 - Basic Materials and Methods.

1.38 STERILIZATION

A. Sterilize interior and exterior water distribution system as soon as water distribution system has been flushed out. System shall be sterilized by the following or other methods satisfactory to Architect/Engineer and State Department of Health. A written certification of the sterilization test & method of testing shall be submitted to Architect/Engineer for their review.

B. Introduce chlorine or a solution of calcium or sodium hypochlorite into entire system of domestic water piping. Fill lines slowly and apply chlorine solution at concentration of 50 parts per million. Open and close all valves and hydrants while system is being chlorinated. Let chlorine solution stand in system 24 hours and test for residual chlorine. Test shall be taken at farthest point in piping system from where chlorine is introduced. If less than 25 ppm is indicated, drain system and repeat sterilization process. After a chlorine residual of at least 25 ppm is obtained, flush system until chlorine content equals that of water supplied by public water system. Architect/Engineer shall be notified 48 hours in advance of above test and his representative shall be present when test is run.

C. The Contractor shall take four (4) water samples as directed by Architect/Engineer and have samples tested by an independent testing agency or as directed by the local Health Department. Test results shall be submitted to the Architect/Engineer.

D. Architect/Engineer reserves right to test water again at any time prior to final acceptance of work and if found unsafe bacteriologically, to require Contractor to rechlorinate system until water is proven equal to that supplied by public system.

1.39 PIPING IDENTIFICATION

A. Stencil all exposed piping, piping above lay-in ceiling, exposed piping located behind and within 4' 0" of all access panels.

B. Stencils shall be machine cut, applied after the final coat of paint using enamel paint, shall be installed on the piping at not over 20 foot intervals (or in each room whichever is greater) and shall have the following heights:

1. On pipe sizes 3" and over letters shall be 2" in height.

2. On pipe sizes smaller than 3", letters shall be 1" in height, colors for lettering shall be as scheduled herein.

C. In addition to the preceding stencils giving identification, provide arrows at each stencil giving the direction of flow of the material. Where flow can be in either direction, provide double ended arrows. Each tee in piping shall be provided with markers on all three outlets. All zones shall be properly marked by zone numbers as noted on the Drawings.

D. All stencils and arrows shall be properly orientated so that descriptive name may be easily read from the floor. Install stencils and arrows on lower curvature of overhead piping and on side panel near bottom or on bottom of ductwork. (Glue-on or stick-on labels are not acceptable.)

E. Schedule Examples

Pipe	Abbr.	Pipe Color Code
Domestic Cold Water	DCW	Blue with Black Letters
Domestic Hot Water	DHW	Blue with Black Letters
Domestic Recirculating Hot Water	DRHW	Blue with Black Letters
Sprinkler Piping	F	Red with White Letters

1.40 CATALOG DATA FOR THE OWNER (MAINTENANCE, OPERATION AND INSTRUCTION MANUALS)

A. The contractor under this Division shall prepare three (3) loose leaf, plastic bound 3 ring binders labeled on front cover, title page and binder edge "Job Title" (as indicated on the contract document) " Fire Protection and Plumbing Operations and Maintenance Data." Each manual shall be subdivided with section tabs and shall contain a title page and index. The title page shall contain the following information:

1. Job Title

2. Heating, Air Conditioning, Fire Protection, Plumbing Operation and Maintenance Manual

3. All Contractor Names, Address, Phone # and Contact Person

4. Architect and Engineer's Name, Address and Phone #

B. Each manual shall contain the following information:

1. Name and address of Consulting Engineer, Contractor, and index of equipment, including vendor (name and address).

2. Complete brochures, descriptive data, etc., on each piece of equipment, including all approved shop drawings. (The contractor must retain three (3) sets of approved shop drawings for this purpose).

3. Complete maintenance and operating instructions and parts list, prepared by the manufacturer, on each major piece of equipment. This includes blow-out views with labeled parts list.

4. All wiring diagrams for equipment and systems and control schematics. See paragraph on wiring diagrams listed herein before.

C. Manuals shall be submitted to the Architect prior to final inspection of the buildings.

1.41 TEMPORARY HEAT AND WATER

A. See Division 1 for temporary heat and water requirements.

1.42 ACCEPTANCE OF MATERIAL AND MANUFACTURERS

A. The Architect/Engineer reserves the right to determine if the contractor's proposed materials and equipment of any one manufacturer is acceptable in lieu of the specified material or equipment.

B. Where materials and equipment are listed on Drawings and specifications as acceptable or equivalent, this does not relieve the contractor and/or manufacturer from providing and proving to Architect/Engineer that their materials and equipment are equivalent to items the Architect/Engineer used as a guide specification.

C. The contractor and manufacturer must confirm to the Architect/Engineer that their equipment and materials will meet the space requirements of the project and that the equipment is easily accessible for maintenance and operation.

1.43 CLOSEOUT DOCUMENTS

A. Prior to this project to be considered as "Substantially Complete" the following documents must be presented and approved.

1. All required approval/inspection letters from the state and local government levels; to include but not limited to:

a. Certificate of Inspection and Approval - Kentucky State Department of Health Plumbing Inspector.

b. Kentucky Department of Housing, Buildings and Construction Approval Letter.

c. Division of Fire Prevention Approval Letter.

d. Kentucky Department of Environmental Protection/Division of Water Approval.

e. Kentucky Cabinet of Human Resources Approval Letter.

2. Owner's Operation and Maintenance Manuals.

3. Approved and mounted valve tag charts.

4. Domestic water (interior and exterior) sterilization report.

5. Record drawings approved and returned to the Architect/Engineer.

6. Evidence that all guarantees and warranties have been submitted on behalf of the owner.

END OF SECTION 220100

SECTION 220200 - PIPE TRENCHING AND BACKFILLING

1.1 GENERAL

A. All work shall be fully coordinated with the architectural phasing plan. The Contractor shall review the drawings and report any conflicts to the engineer prior to bid.

B. The General Conditions, Special Conditions, Site Work and other Contract Documents shall apply to this Division of the work as well as to all other Divisions.

C. The Contractor under this Division shall do all excavation, backfilling, and grading required for this part of the work. Excavation shall include all earth, rock and other materials necessary for the installation of the new work. No sub surface data available except as noted in site work of the Specifications. All trenching work is unclassified except as noted in site work Specification.

D. See Site Utility Plans for utility work.

E. Lay in all pipe in open trenches. Open the trench sufficiently ahead of pipe laying to reveal obstruction.

F. Provide trench crossings as necessary to accommodate public travel.

G. See the following Articles for special requirements for Plumbing work.

H. No blasting will be allowed on this project unless approved by Architect.

I. Contractors must use extreme care in all excavation work and protect all existing utilities.

1. Contractors must comply with local utility companies requirements if more stringent than listed herein.

J. All underground utility lines shall have a #10 coated copper tracer wire laid in trench with pipe and at 14" below finished grade provide 2" wide tracer tape.

1.2 EXCAVATION

A. Separate Trenches

1. Unless otherwise shown or required, provide separate trenches for all services (sewers, water lines, etc.) with a minimum of three feet (3') of undisturbed earth between trenches. (All utilities installation must be coordinated with local utility companies and comply with their requirements; this includes materials and installation procedures).

B. Width of Trench

1. Excavate trenches of sufficient width for proper installation of work. When depth of backfill over sewer pipe exceeds ten feet (10') keep the trench at the level of the top of pipe as narrow as practicable.

C. Shoring and Bracing

1. Shore and brace trench as necessary to protect workmen and adjacent structures. Comply with local regulations or in the absence thereof, with the "Manual of Accident Prevention in Construction", of the associated General Contractors of America, Inc. Do not remove shoring until trench is backfilled sufficiently to protect pipe and prevent injurious caving.

D. Water Removal

1. Keep trenches free from water while construction therein is in progress. Under no circumstances lay pipe or appurtences in water. Pump or bail water from bell hole to permit proper jointing of pipes. Conduct the discharge from trench dewatering to drains or natural drainage channels.

E. Disposition of Utilities

1. Local and state rules and regulations governing the utilities in this area shall be observed in executing all work under this heading. Active utilities shall be protected or relocated in accordance with instructions of the Architect, Owner, and Local Utility. Inactive and abandoned utilities encountered in trenching operations shall be removed, plugged or capped. In absence of specified requirements, plug or cap such utility lines at least three feet (3') from utility line to be installed or as required by the local regulations. Extreme care must be taken in all excavation work, since active utility lines are present throughout the area. Repair all damaged utility lines in strict accordance with the respective utility company's requirements. Coordinate with all local utility companies and the Owner prior to any excavation work. Interruption of any utilities shall be scheduled with the owner and approved a minimum of 72 hours in advance. Interruption of utilities either schedule or by accident, the Contractor shall work continuously until service is restored.

F. Grading Trench Bottom

1. Grade the bottom of trenches evenly to insure proper slope for drainage. Perform final grading of trench bottom by hand and carry machine excavation only to such depths that soil bearing for pipes will not be disturbed. For piping to be laid on a grillage, excavate trenches to at least four inches (4") below the required bottom levels and refill to the proper grade with grillage specified hereinafter under Backfilling.

1.3 BACKFILLING

A. The utility piping systems shall be laid on a grillage of at least 6" of No. 9 crushed stone. After the systems have been installed and tested, install at least 12" of No. 9 crushed stone over piping and firmly compacted using mechanical tamper.

B. Backfill trenches only after piping has been inspected, and locations of pipe lines and appurtenances have been recorded. (See Section 220100 for requirements of underground utilities trace tape and tracer wire).

C. For depth of at least 12 inches above the top of the compacted crushed stone noted above, backfill with clean earth or crushed stone (free from rock fragments, roots, sod, cinders, junk, refuse, scrap iron, and unused portions of welding rods). Tamp this backfill thoroughly (using mechanical tamper) in layers not exceeding 12" in thickness, taking care not to disturb the pipe or injure the pipe coating.

D. For the remaining trench depth, backfill with earth as specified in the preceding paragraph, except that the material may contain stones or rocks with a maximum dimension of four inches (4"), providing the voids in such coarse materials are completely filled with earth or granular material. In the event that sufficient suitable material, as specified here for trench backfill, is not available from trenching or other excavation for the project, the Contractor shall supply and place the requisite additional material without increase in the Contract Price. Compact thoroughly the backfill herein referred to with an approved mechanical tamper. Compaction must be similar to surrounding conditions. Backfill under all sidewalks, concrete slabs, and pavements

shall be 100% #9 crushed stone or dense grade aggregate to under side of slab or pavement. Compact solidly with mechanical tamper in layers not more than six (6) inches.

E. Install tracer wire and tracer tape in trench during backfill as noted above.

1.4 GRADING

A. Finish grading of trenches on the site shall be as shown on the Architectural Drawings and stated in Division 31, and as directed by Architect.

B. For offsite trenching or trenching beyond the normal construction limits, backfill shall be brought to existing grades.

C. Excess earth and other excavated material shall be removed from the property, unless otherwise directed by Owner.

1.5 RESTORATION OF SURFACES

A. The Contractor under this Division shall restore to their original conditions all sod, paving, curbing, surfaces, drainage ditches and structures, fences, curbs, and other items damaged or removed by his operations, which are not covered under other sections of the specifications to be replaced or repaired. Replacement and repairs shall be in accordance with good construction practice and shall match material employed in the original construction of the item to be replaced.

END OF SECTION 220200

SECTION 220300 - PLUMBING BASIC MATERIALS AND METHODS

1.1 TESTS

A. The Architect/Engineer shall be notified by the Contractor under this Division forty eight (48) hours in advance of any tests so that the Architect/Engineer, or his representative may be present when the tests are run. Leaks or imperfections found shall be corrected and a new test shall be run to the satisfaction of the Architect/Engineer. Upon successful completion of the test, pipe covering may be applied and piping may be concealed. A successful test, even if witnessed, however, does not relieve the Contractor under this Division of the responsibility for any failure during the guarantee period.

B. After pipe fabrication has been completed, all water piping shall be subjected to a hydrostatic test of 100 psi and proven tight and free of leaks for a 24 hour period. Tests shall be applied to the piping before being attached to any equipment which would be damaged by the test pressure. Damage to equipment caused by testing shall be repaired or replaced without additional cost to the Owner.

C. The sanitary sewer piping and sanitary waste, vent and drainage piping installed under this Division in, under or outside the building shall be tested by means of water, smoke or air in accordance with the Kentucky State Plumbing Law, Regulation and Code, Division of Water Quality and the local utility company requirements. These shall be made in the presence of the Plumbing Inspector and the Architect/Engineer.

D. Exterior water piping shall be tested in strict compliance with local water company. The minimum hydrostatic test pressure is 1 1/2 times the water pressure serving the site.

E. No insulation, paint, backfill or other prohibitive covering shall be applied to piping prior to the above tests.

F. Provide all temporary equipment, materials, valves, gauges, etc., required for the preceding tests.

G. The expense of all tests shall be borne by the Contractor under this Division.

2. EXPANSION OF PIPING

A. Risers and horizontal runs shall be equipped with the necessary expansion loops or arms to accommodate maximum expansion anticipated. Runouts to risers shall have offset swings between main and riser.

B. Provide expansion loops at the locations and of the dimensions shown on the Drawings and as required per field conditions.

3. GRADING OF PIPING

A. Domestic Hot and Cold Water Piping

1. Water piping, except that installed "dead level" as necessary, shall be pitched down 1/4" in 10 feet toward low points so that the entire system can be drained completely.

B. Soil, Waste, Drainage and Vent Piping, Roof Leaders

1. Soil, waste, drainage and vent piping and roof leaders shall pitch 1/4" per foot where practicable, but in no case shall the pitch be less than 1/8" per foot.

4. PIPE ANCHORS

A. Provide anchors at the locations shown on the Drawings and as required per field conditions.

B. Anchors shall consist of heavy steel collars welded to pipe and secured to the building structure to prevent movement of piping.

C. Anchors shall be approved by the Architect/Engineer before installation is started.

5. PIPE SUPPORTS

A. Piping shall be run parallel to the building walls and shall be grouped in neat rows. Piping shall be supported to maintain required grading and to prevent vibration and shall be arranged to allow for expansion and contraction. Hanger rods longer than three feet (3') shall be restrained to prevent swinging of the pipes. Hangers shall be sized in accordance with the manufacturer's recommendations.

B. Where piping is to be supported from the concrete construction, provide inserts installed directly in the slabs. Concrete inserts shall be malleable iron; Grinnell Figure 282.

C. Where piping is to be supported from steel joist construction, provide supplementary steel angles or steel pipe welded between joists, or the use of approved joist and beam clamps. Steel members spanning between joists shall be attached to the top chord of joists not bottom chords. Where piping is to be supported from wood joist construction, hangers shall be supported by bolts thru center of joist.

D. In areas where concrete floors over steel decking is used, drill holes through deck into concrete and use expansion shields. Proof load of expansion shields in pull out shall be four times applied load. Steel decking alone shall not be used to support ductwork, piping, equipment, etc.

E. Piping, except as hereinafter specified, shall be supported by hangers, supports and/or stands, of the following Grinnell Figure Numbers:

1. Hangers

PIPE SIZES	HANGER
5" and smaller	260, steel clevis
Bare copper	CT 99 (copper plated), or CT 99C (plastic coated)

2. Stands

PIPE SIZES	FIGURE NUMBER
All sizes	274, adjustable prior pipe roll

F. Hangers and stand supports for all horizontal cold water lines shall be sized for the outside diameter of the insulated pipe. Insulation shall pass unbroken through the hanger and shall rest on insulation protector saddles fabricated from 20 gauge sheet steel. Saddles shall be 9" long and have an arc of approximately 120 degrees. Saddles may be job made or shall be Grinnell Figure No. 167.

G. Brackets for downfeed piping serving heating units shall be Fee and Mason No. 302 split ring extension hanger. Brackets shall be sized to fit the bare pipe.

H. Vertical plumbing piping shall be supported by Figure 261 riser clamps at each floor.

I. Steel supports, other than designed building structural members, required for support of piping installed under this Section of the Specifications, shall be furnished and installed under this Division.

J. Piping supports shall not be attached to any equipment having moving parts. Supports shall be independent of equipment by brackets to the floor, walls, or columns.

K. Maximum spacing of supports shall be as follows:

PIPE SIZES	SPACING
1 1/2" and smaller	8'
2" and larger	8'
Polyethylene Piping	5'
Cast iron pipe	Each length or 8' maximum

L. Comparable hangers, supports, etc., as manufactured by Fee and Mason, Elcen, or B-Line, Gateway will be considered equal to the Grinnell products providing the specifications are fully met. ½" through 2" pipe shall have 3/8" diameter hanger rods; 2 ½" and 3" pipe shall have ½" diameter hanger rods; 4" through 5" pipe shall have 5/8" diameter hanger rods; 6" through 8" pipe shall have ¾" diameter hanger rods.

6. PIPE AND PIPE FITTINGS

A. General

1. The General Conditions, Special Conditions, and the applicable portions of Division 1 of the Specifications are a part of this section.

2. The Contractor for this work shall be governed by any Alternate Bids requested insofar as they affect his work.

B. Scope

1. All work shall be fully coordinated with the architectural phasing plan. The Contractor shall review the drawings and report any discrepancies to the engineer prior to bid.

2. This work includes the furnishing of all pipe and pipe fittings, materials, equipment, labor, etc., necessary for the proper and complete installation of systems and equipment as shown on the drawings and/or herein specified.

C. Installation

1. All sanitary soil, waste and vent piping shall be installed in accordance with the latest revisions of the Kentucky State Plumbing Code.

2. In general, all piping shall be installed concealed except in mechanical, storage, janitor rooms, etc., and shall be installed underground or beneath concrete slab on grade only where indicated. All lines at ceilings shall be held as high as possible and be run to avoid conflicts with other trades, and to facilitate the owner's use and access.

3. Piping shall be installed straight and true, parallel or perpendicular to walls, with approved offsets around obstructions. Standard pipe fittings shall be used for changing direction of piping. No mitered joints or field fabricated pipe bends are permitted, except that copper pipe 1/2" and smaller may be bent in the field with approved bending equipment, if authorized by the Engineer.

4. Tee connections for welded pipe shall be made up 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, socket o let, or thread o let type fitting may be used for the side outlet in place of reducing tees only where the outlet is 2/3 of the run size, or smaller.

5. Short radius elbows may be used only where specifically authorized by the Architect/Engineer.

6. Unless otherwise indicated on the Drawings, all piping shall be pitched to permit drainage and venting. Air vent lines shall be provided in all liquid under pressure at all high points and at drops in direction of flow and where otherwise indicated. Air vent valves in all water lines, except potable water lines, shall be manual type unless otherwise indicated and be piped to drain or as directed by the Architect/Engineer. All vents shall be installed easily accessible locations with extensions to cabinet face where installed in radiation cabinets.

7. Piping shall be erected to provide for expansion and contraction without harmful strain to building structural members, pipe and vibrating equipment. Provide expansion bends or devices other than those indicated if, in the opinion of the Engineer, such devices are required by field conditions. Unless indicated otherwise, expansion bends are preferred to the use of expansion joint and shall not be substituted without the permission of the Engineer. Expansion bends in steel pipe shall be made using long radius welding elbows. Expansion loops shall be cold sprung and welded into the line, which shall be anchored before removing the spreader from the expansion U bends.

8. Expansion loops, swing ells of joints shall be installed where indicated and where specified herein. Design and installation of expansion joints shall be such as to provide for the stresses and strains imposed by connected piping and vibrating equipment and by operating pressures, test pressures and temperatures.

9. Ream all pipe ends and thoroughly clean dirt, chips and foreign matter from all piping, fittings, valves and other accessories before joint connections are made.

10. Screwed joints shall be made with oil and graphite or other approved compound. Joint compound shall be applied to the male threads only and care shall be exercised to prevent compound from reaching the interior of the pipe.

11. Screwed unions, welded unions or bolted flanges shall be provided as required to permit convenient removal of equipment, valves and piping accessories from the pipe system. In concealed locations, union nuts shall be center punched to prevent loosening from vibration. Leave adequate clearances for rodding, motor lubrication, etc.

12. Copper tubing connections for water piping shall be made up with 95/5 tin antimony solder (50/50 solder not acceptable) in accordance with the recommendations of the manufacturer. Brass valves for use in copper piping 2" and larger shall have screwed or flanged ends with screwed or companion flanges and adapters to suit. Brass valves smaller than 2" may be soldered, but extreme care must be taken to prevent heat damage to valve.

13. Dielectric insulating unions or dielectric couplings shall be used wherever the adjoining materials being connected are of dissimilar material such as connections between copper tube and steel pipe.

14. Flanged joints shall be assembled with appropriate flanges, gaskets and bolting. The clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system. Flange faces shall be parallel and the bores concentric; gaskets shall be centered on the flange faces so as not to project into the bore. Bolting shall be lubricated

before assembly to insure uniform bolt stressing. The flange bolts shall be drawn up and tightened in staggered sequence in order to prevent unequal gasket compression and deformation of the flanges. Wherever a flange with a raised face is used, the face shall be machined down to a smooth matching surface and a full face gasket shall be used.

15. Piping shall not be installed in locations subject to freezing; if in doubt, consult Engineer. Exterior lines shall have a minimum earth cover of 36 inches unless otherwise noted.

16. Eccentric reducers shall be used where required to permit proper drainage and venting of pipe lines; bushings are not permitted for this purpose. Drain valves shall be provided in all piping systems at low points and otherwise indicated. Blow off valves shall be provided in all piping at strainers where indicated hereinafter.

17. Provide pipe anchors as noted hereinbefore. Anchors shall consist of heavy steel collars welded to pipe and secured to the building structure to prevent movement of piping. All anchors shall be approved by the Architect/Engineer, before installation is started.

18. Condensate drain lines from cooling equipment shall be pitched and installed with brass plug cleanouts at each change in direction and/or at 20' intervals.

19. At each fixture and piece of equipment, provide appropriate shutoff valves and unions.

20. Materials shall be new and of the best grade and quality; workmanship shall be first class in every respect.

21. All thread shall conform to ANSI B16.3 for American Standard Taper Pipe Threads.

22. Chain or wire rope slings for handling pipe shall not be allowed unless padded to prevent marring of protective coating on pipe.

23. Lock type mechanical joints shall be made up tight, but shall allow for 1/8" contraction of the pipe at each joint.

24. Pipe shall be kept clean at all times, especially the interior and joint surfaces. When no work is in progress the pipe shall be capped or plugged to prevent the entrance of water or dirt. Before any cast iron or ductile iron pipe is laid, it shall be lightly tapped with a hammer while suspended above the ground; sound pipe will emit a clear ring sound, unsound pipe will emit a dull sound. Unsound pipe shall not be laid and shall be rejected.

25. All steel surfaces such as tie rods, flanges, bolts, nuts, etc., to be buried in the earth, shall be protected with a 1/4" minimum coating of filtrated bituminous compound after installation and prior to backfill. Protective coating shall be Sonneborn "Hydrocide Mastic", Lambers "Waterban #60M", Emulsified Asphalts "Multiseal" or equivalent. Application shall be in strict accordance with manufacturer's directions. All existing steel surfaces uncovered by excavation shall be thoroughly cleaned and treated in a like manner.

26. Plastic piping shall not be installed in any facility in a manner that would require penetration of one hour or greater fire resistive wall, ceiling or shaft. Unprotected plastic piping shall not be installed in any area that is used for the

transfer of environmental air (plenum) in accordance with the Kentucky State Building Code.

27. Solder joints for water systems; use 95/5 tin antimony (50/50 solder not acceptable).

28. Material shall be new and of the best grade and quality; workmanship shall be first class in every respect.

29. Soil, waste, and vent piping shall pitch 1/4" per foot where practicable, but not less than 1/8" per foot or as indicated.

30. All piping must be installed to allow proper access to equipment, access doors, valves, motors, etc.

D. Standards

1. ASTM D 1784: Rigid Vinyl Compounds
2. ASTM D 1785: PVC Plastic Pipe, Schedule 40
3. ASTM D 2466: PVC Plastic Fittings, Schedule 40
4. ASTM D 1784: Rigid Vinyl Compounds
5. ASTM D 2846: CPVC Plastic Hot and Cold Water Distribution System
6. ASTM F 493: Solvent Cements for CPVC Pipe and Fittings
7. ASTM F 1668: Procedures for Buried Plastic Pipe
8. NSF Standard 14: Plastic Piping Components & Related Materials
9. NSF Standard 61: Drinking Water System Components–Health Effects.
10. Steel Pipe: ASTM A 120 or A 53; plain and galvanized.
11. Copper Tube: Type K, L, M; ASTM B 88.
12. Copper Tube: Type DWV; ASTM B 306.
13. Soil Pipe: ASTM A 74.
14. Welded Fittings: ANSI B 16.9.
15. Weld Flanges: ANSI B 16.5.
16. Cast Iron Screwed Fittings: ANSI B 16.4, Plain and galvanized.
17. Malleable iron screwed fittings: ANSI B 16.3.
18. Cast iron drainage fittings: ANSI B 16.22; Plain and galvanized.
19. Cast iron flanged fittings: ANSI B 16.1.
20. Wrought copper flanged fittings: ANSI B 16.1.
21. Cast bronze drainage fittings: ANSI B 16.23.
22. Cast iron soil pipe fittings; ASTM A 74.
23. Solder: Handy and Harman, United Wire and Supply and Air Reduction Company.

E. Relief Valve Piping

1. Piping shall be Type "L" Hard Copper.
2. Fittings shall be wrought copper or precast brass with solder joint; 95/5 tin antimony solder.

F. Soil, Waste, and Vent Piping (Interior)

1. Piping
   a) Below Slab
      (1) Sanitary DWV piping below slab and in earth inside building shall be service weight cast iron with cast iron hub and spigot fittings and approved neoprene compression gaskets, or Schedule 40 PVC plastic fittings meeting the requirements of the Kentucky Plumbing Code.
   b) Above Slab
      (1) All other sanitary DWV piping above slab shall be Schedule 40 PVC plastic, service weight cast iron no-hub with no-hub fittings and couplings. Couplings shall be elastomeric with stainless steel shields and bands, or DWV copper meeting the requirements of the Kentucky Plumbing Code. Use of PVC requires PVC to cast iron adapters when connecting to cast iron drain line. PVC pipe shall not be used in return air or relief air plenums.

G. Domestic Hot Water, Cold Water and Re-circulating Hot Water (Interior)

1. Piping
   a) Piping above slab shall be Type L hard copper.
   b) Piping below slab shall be Type "K" copper. Solder joints with silver solder brazing alloy.
2. Fittings shall be wrought copper or precast brass, solder joint type. T-drill method with brazed joint is acceptable.
3. Furnish and install hot and cold water piping to all fixtures and equipment requiring these respective services. The piping shall be installed at locations and of the size shown on the Drawings or as required for a complete and operating system.

H. Unions

1. Copper pipe 2" and less; 125#; brass; solder end; ASA.
2. Copper pipe 2 1/2" and more; 150#; brass; solder end.
3. Flange unions to have proper gaskets for applicable service.

I. Polyvinyl Tape

1. Johns Manville, Minnesota Mining and Mfg., Union Carbide or equivalent; similar to Johns Manville No. V 20; 0.02" thick; polyvinyl.

J. Escutcheons

1. Escutcheons shall be Beaton and Caldwell; Carpenter and Patterson; Fee and Mason or approved equivalent. Escutcheons shall be set screw type for permanent installation.

2. Exposed bare and insulated piping passing though floors, walls, or ceilings of finished rooms shall be provided with chrome plated escutcheons. Plates shall be of the split, hinged type of sufficient outside diameter to amply cover up the sleeve openings for the pipe. Beaton and Caldwell No. 10.

3. The Contractor's attention is called to the fact that most of the escutcheons will be installed around insulated pipe. It will be necessary that the plates fit snugly around the insulation and will be firmly held in place. Insulation shall not be cut or notched in any way.

4. Provide chrome plated escutcheons for hanger rods in finished ceilings. Carpenter and Patterson #182.

K. Insulating Dielectric Unions and Couplings

1. Epco type GX or DX as required, Walter Vallett Co., Capitol Mfg. Co., Victaulic, or equivalent, for use in connecting dissimilar metals.

2. Furnish and install hot and cold water piping to all fixtures and equipment requiring these respective services, install hot recirculating water where shown. The piping shall be installed at locations and of the size shown on the Drawings or as required for a complete and operating system.

L. Domestic Water Piping (Exterior)

1. Piping 4" and larger shall be PVC meeting the minimum requirements of AWWA C900, Class 200, 200 PSI. Joints and fittings shall be slip joint rubber ring type; 45/90 degree turns and tees shall be Ductile iron with bolted flange fittings. Provide thrust blocks at all turns in strict accordance with manufacturer's requirements. Piping shall be CAPCO Class 200, Johns Manville, Blue Brute Class 200 or equivalent. The Contractor shall coordinate with the local water company and include in his bid all costs involved in extending the water main to the building, installing the water meter and providing all water piping as required, all tap-on fees and meter costs.

2. Piping 3" and smaller shall be PVC Class 200, 200 PSI with solvent weld fittings. Provide ductile iron joint fittings at underground valve connections and thrust blocks as required.

3. All water piping underneath roadways, driveways or parking lots shall be ductile iron class 50 or 51 in accordance with the KY Plumbing Code and the local authority having jurisdiction. Contractor to confirm class prior to bid. Piping to be rated for 150 psi working pressure. Interior of the pipes shall be cement mortar lined with bituminous seal coat. Exterior of the pipe shall receive either coal tar or asphalt base coating. All piping and fittings must be provided in strict accordance with the Plumbing Code and water company requirements. Each piece of pipe shall bear the manufacturer's name or trade mark, the year in which it was produced and the letters, DI or ductile shall appear on the exterior of the pipe. Joints and fittings shall be slip joint, rubber ring type; 45 degree and 90 degree turns shall be Ductile Iron with bolted flange fittings. Where piping is less than 3" but required to be ductile iron, provide PVC/C900 transitions to 3" ductile iron as required.

4. Provide thrust blocks at all turns in strict accordance with manufacturer's requirements.

M. Interior and Exterior Gas Piping and Equipment

1. Gas Piping

a) Exposed exterior gas piping shall be schedule 40 black steel, ASTM A 120. Screwed fitting shall be 150 lb. malleable iron. Welded fittings shall be standard weight, Grade A welding fittings, and shall conform with the American Standards Association's latest Specification No. B16.9. All 90 degree elbows except for connection to equipment or as otherwise indicated on Drawings, shall be long radius. All exposed exterior piping, fittings and brackets shall be painted with a suitable primer and gloss enamel or as approved by the local utility company and engineer. Color as selected by the Architect/Engineer.

b) Shut off valves (gas cocks) shall be lubricated plug type with screwed ends. Valves shall be Homestead #601, Stockham, Rockwell or equivalent. All valves shall have lever handle operators.

c) All gas piping and gas regulators from the main to the emergency generator shall be provided by this Contractor and all work coordinated with the electrical contractor.

d) All work shall be coordinated with the gas company.

2. Underground gas piping material(s) and installation shall be per the specifications of the Gas Company and shall be non-metallic underground valving and plastic to metal connections shall be protected by a sacrificial anode in accordance with the utility company's requirements.

3. All gas piping shall be installed in strict accordance with NFPA 54 and gas company requirements. Provide all grade stakes and/or pipe brackets at risers near equipment as required by code and the local gas company requirements.

4. Performance Requirements

a) Minimum Operating-Pressure Ratings:

i. Piping and Valves: 100 psi

ii. Service Regulators: 65 psi

b) Natural-Gas System Pressures within Building:

iii. Two Pressure Ranges: 0.5 psi (3.45 kPa) or less.

5. Pressure Regulators:

a) Service pressure regulators.

b) Line pressure regulators.

c) Appliance pressure regulators.

6. Outdoor Piping Schedule

a) Underground Piping: PE pipe with heat-fusion joints

b) Aboveground Piping: Schedule 40 steel pipe with threaded or welded joints

7. Indoor Piping Schedule for Pressures Less Than 0.5 psi

   a) Aboveground Branch Piping NPS 2" and Smaller: Steel pipe with threaded joints.

   b) Aboveground Distribution Piping NPS 2-1/2" and larger: Steel pipe with welded joints.

8. Underground Piping: Corrugated pre-vented flexible gas piping equivalent to trac-pipe. Vent to atmosphere.

N. Unions

1. Copper pipe 2" and less; 125#; wrought copper alloy; solder end.
2. Copper pipe 2 1/2" and more; 150#; wrought copper alloy; solder end.
3. Flange unions to have proper gaskets for applicable service.

O. Polyvinyl Tape

1. Johns Manville, Minnesota Mining and Mfg., Union Carbide or equivalent; similar to Johns Manville No. V 20; 0.02" thick; polyvinyl.

P. Escutcheons

1. Escutcheons shall be Beaton and Caldwell; Carpenter and Patterson; Fee and Mason or approved equivalent. Escutcheons shall be set screw type for permanent installation.
2. Exposed bare and insulated piping passing though floors, walls, or ceilings of finished rooms shall be provided with chrome plated escutcheons. Plates shall be of the split, hinged type of sufficient outside diameter to amply cover up the sleeve openings for the pipe. Beaton and Caldwell No. 10.
3. The Contractor's attention is called to the fact that most of the escutcheons will be installed around insulated pipe. It will be necessary that the plates fit snugly around the insulation and will be firmly held in place. Insulation shall not be cut or notched in any way.
4. Provide chrome plated escutcheons for hanger rods in finished ceilings. Carpenter and Patterson #182.

Q. Insulating Dielectric Unions and Couplings

1. Epco type GX or DX as required, Walter Vallett Co., Capitol Mfg. Co., Victaulic, or equivalent, for use in connecting dissimilar metals.

R. Unions

1. Copper pipe 2" and less; 125#; wrought copper alloy; solder end.
2. Copper pipe 2 1/2" and more; 150#; wrought copper alloy; solder end.
3. Flange unions to have proper gaskets for applicable service.

S. Polyvinyl Tape

1. Johns Manville, Minnesota Mining and Mfg., Union Carbide or equivalent; similar to Johns Manville No. V 20; 0.02" thick; polyvinyl.

T. Escutcheons

1. Escutcheons shall be Beaton and Caldwell; Carpenter and Patterson; Fee and Mason or approved equivalent. Escutcheons shall be set screw type for permanent installation.

2. Exposed bare and insulated piping passing though floors, walls, or ceilings of finished rooms shall be provided with chrome plated escutcheons. Plates shall be of the split, hinged type of sufficient outside diameter to amply cover up the sleeve openings for the pipe. Beaton and Caldwell No. 10.

3. The Contractor's attention is called to the fact that most of the escutcheons will be installed around insulated pipe. It will be necessary that the plates fit snugly around the insulation and will be firmly held in place. Insulation shall not be cut or notched in any way.

4. Provide chrome plated escutcheons for hanger rods in finished ceilings. Carpenter and Patterson #182.

U. Insulating Dielectric Unions and Couplings

1. Epco type GX or DX as required, Walter Vallett Co., Capitol Mfg. Co., Victaulic, or equivalent, for use in connecting dissimilar metals.

1.2 VALVES

A. Installation

1. Where required for ease of operation of valves and wherever elsewhere required by the Drawings, valves shall have extension stems.

2. All valves shall be of the same manufacturer insofar as possible.

3. In no case shall valves be installed with the stems below the horizontal.

4. Valves located above ceilings and in accessible pipe chases shall be provided with access panels.

5. Valves for water service shall be built for not less than 125 lbs. W.S.P., 200 lbs. W.O.G., 450 degrees F flanged valves shall have standard weight flanges.

6. Provide the required wrenches or handles to operate valves and cocks. A set of wrenches of handles shall be mounted on a finished plywood panel and installed in the Boiler Room where directed.

7. Bronze valves for use in copper piping 1/2" and larger shall have screwed or flanged ends with screws or companion flanges and adapter to suit. Brass valves smaller than 1 1/2 inches may be soldered but extreme care must be taken to prevent heat damage to valve. Comply strictly with manufacturer's requirements.

8. Valves shall be the same size as the line in which they are installed unless otherwise noted.

9. The following paragraphs mention usually Nibco and Dezurik No.'s to establish desired quality. Comparable valves by Milwaukee, Grinnell, Crane, Kennedy, Lunkenheimer, Walworth, Jenkins, Jamesbury, Apollo, Keystone, Kunkle, Mueller, Pegler, Homestead, Red/White and Stockham will be considered equal.

B. Swing Check Valves

1. Check valve 2" and smaller, Nibco No. T 413 Y, screwed, bronze, swing check, renewable TFE disc, 125 lbs. steam/200 lbs. WOG, working pressure.

2. Check valve 2 1/2" and larger, Nibco No. F 918 B, I.B.B.M., flanged, with bolted cap, swing check, renewable seat and disc, 125 lbs. steam/200 lbs. WOG, working pressure.

C. Ball Valves

1. Nibco No. T 585 70; anti blowout stem; Body shall be bronze, two piece, with screwed ends. Ball shall be hard chromium plated bronze. Seats stem packing seal and thrust washer shall be RTFE. Valve handle and nut shall be cadmium or zinc plated steel, with non heat vinyl grip. Valve shall be operated from full open to full closed by turning the valve handle one quarter turn (90 degrees) and the valve handle shall indicate ball position. Valve shall be suitable for flow in either direction. Valve assembly shall be rated 150 P.S.I. SWP and 600 P.S.I. WOG, for 1/4" through 2" sizes; valves shall be full port 1/4" thru 1" and conventional port 1 1/4" thru 3".

D. Balancing Valve Flow Indicator (Plumbing Domestic Hot Water)

1. Balancing valves shall be Flowset, Accusetter, Armstrong, Gerand, or equivalent, with flow indicator and memory stop for shut off use without changing balance set point. Provide a minimum of 24" of straight run of piping on each side of balancing valve/flow indicator assembly.

E. Relief Valves

1. Provide relief valves for all pressure systems including domestic hot water heaters, boilers, storage tanks, water source heat pump loop piping as required by manufacturers, prevailing codes or insurance requirements.

2. Relief valves for domestic water heaters and storage tanks shall be combination pressure and temperature type with pressure setting of 125 psi and temperature setting of 210 degrees F.

3. Discharge these relief valves over to floor drain or as shown and noted on Drawings.

4. All relief valves shall be lever handle operated, A.S.M.E. approved as manufactured by Watts, McDonnell Miller, Kunkle, or equivalent. Coordinate relief valve setting and sizing with equipment manufacturers.

5. Water heaters and boilers shall be provided from the factory with code approved relief valves sized, located and installed in strict accordance with code and manufacturer's requirements.

F. Silent Check Valves

1. Silent check valves 2" and smaller, Nibco No. T-480Y; screwed; 125 p.s.i. steam/250 p.s.i. WOG; 3 lb. stainless steel spring; bronze body; stainless steel stem; TFE disc and seat ring.

2. Silent check valves, 2 1/2" and larger, Nibco No. W-960 (wafer) or F-960 (flanged); cast iron body; type 302 stainless spring; bronze disc; Buna N bonded to bronze seat; 250 lb. W.O.G.

3. All check valves at pumps shall be silent type.

G. Gauge Cocks

1. Ashcroft No. 1092; 150 PSIG maximum working pressure; bronze; 1/4" screwed connections; tee handle.

2. All pressure gauges shall be installed with a gauge cock.

H. Recirculation Pumps

1. Refer to section 220700

I. Backflow Preventer for Domestic Water Service (PRZ)

1. Refer to section 220700

1.3 MISCELLANEOUS PLUMBING. SPECIALTIES

A. Thermometers

1. Weiss No. 9VS type vari-angle 9" mercury filled heavy duty type; Marshalltown, Ashcroft, Marsh, or equivalent, Accuracy within 2% of scale span. Brass 3 1/2" (min.) stem complete with separable socker. Stem and socket must be of adequate length to give accurate temperature readings. Install in piping system in strict accordance with manufacturer's requirements. Increase pipe sizing at thermometer as required. Range 30 to 240 degrees F. for hot water piping, and 0 120 degrees F, for heat pump loop water, unless other standard range selected upon submittal. Contractor shall adjust case for readability from floor line.

B. Pressure Gauges

1. Weiss Series UG 1, Ashcroft, Marsh, Marshalltown or equivalent. 4 1/2" dial, range selected upon submittal; with maximum pointer; brass bourdon tube and socket; 1% accuracy.

2. All pressure gauges shall be installed with lever handle gauge cock and brass straight coil siphon tube.

C. Strainers

1. Strainers shall be Y type equal to Leslie, Illinois, or Mueller. Sizes 2 1/2" and larger shall be flanged; sizes 2" and smaller shall be screwed.

2. Water strainers shall be cast iron or brass, designed for 125 lb. steam/200 lbs. WOG working pressure.

3. Strainers shall have a free area of strainer screen a minimum of twice the area of the adjoining pipe. Strainer baskets shall be fabricated from stainless steel or monel sheet metal; baskets shall have 0.045" (3/64") perforations for water service.

4. Strainers shall have short nipple and ball valve provided on blow off, sized the same as blow off size. Where strainers are located more than 3' above floor, blow off line shall be offset to wall or column and extended down to 3' level and then valve provided. Provide nipple and cap on smaller strainers, in addition to ball valve, at AHU's, FCU's and UV's for easy maintenance blow-off.

END OF SECTION 220300

SECTION 220400 - PLUMBING INSULATION

1.1 GENERAL

A. The General Conditions, Special Conditions and the applicable portions of Division 1 of the Specifications are a part of this Section.

B. The Contractor for this work shall be governed by any Alternate Bids requested insofar as they affect this work.

1.2 SCOPE

A. All work shall be fully coordinated with the architectural phasing plan. The Contractor shall review the drawings and report any discrepancies to the engineer prior to bid.

B. This work includes the furnishing of all insulation and labor, materials, equipment, etc., necessary for the proper and complete installation of insulation as shown on the Drawings and/or herein specified.

1.3 SHOP DRAWINGS

A. Shop Drawings shall be submitted on all insulation including name of manufacturer, materials of construction, manufacturer's details of installation, procedures, mastics, tape, glass cloth, molded fittings, etc. Shop drawings shall include all equipment, materials and accessories incidental to a proper and complete installation.

1.4 ACCEPTABLE INSULATING MATERIAL MANUFACTURERS

A. Insulations having the thermal and physical properties of the specific materials specified hereinafter, of any of the following manufacturers, or approved equal, are acceptable.

Armstrong Cork	Knauf
Johns Manville	Certain Teed/Saint Gobain
Owens Corning	Pittsburgh Corning
Rubatex	

B. The Architect reserves the right to determine if the proposed insulating materials of any one manufacturer are acceptable in lieu of the specific insulation selected for the following applications.

1.5 INSTALLATION

A. All workmanship shall reflect the best current practices in the trade. Installation shall be applied by an approved company regularly engaged in the application of insulation. A neat and workmanlike job will be required. No covering shall be applied to pipe lines equipment until they have been tested and accepted by the A/E.

B. Contours on exposed work shall be smooth and continuous. Cemented laps, flaps, bands and tapes shall be smoothly and securely pasted down; adhesives shall be liberally used in conformity with the requirements of the manufacturer.

C. Where more than one thickness of insulation is required, joints (both longitudinal and transverse) shall be staggered. All joints shall be tight and with insulation lengths tightly butted against each other. Where lengths are cut, cuts must be smooth and square and without breakage of end surfaces. Where insulation terminates at unions, equipment, etc., ends shall be neatly tapered and effectively vapor sealed where insulation is vapor

sealed. All insulation shall be continuous through wall and ceiling openings and sleeves. Penciling and stove piping of pipe insulation will not be permitted.

D. On vapor sealed insulation, the vapor barrier shall be continuous over all insulation. Insulation (and vapor seal if required) shall be continuous through pipe sleeves and pipe hangers, unless otherwise specified.

E. It shall be understood that except where they deviate from specific requirements hereinafter written, all material shall be applied in strict accordance with the recommendations of the manufacturer, using their recommended mastics, clips, etc., and installation procedures.

F. Provide canvas jacket in addition to standard jacket on all exposed insulated piping (up to 6 ft. above finished floor) in Mech Room and size for painting. Canvas shall be 8 ounce enameling canvas attached with polyvinyl acetate adhesive.

G. Insulation shall extend through hanger and support shield for all cold water piping to be hung in horizontal. Where piping is 2 1/2" and larger, a high compression cork or wood pipe support shall be installed under pipe.

H. For vertical piping, the bracket shall fit directly to pipe and insulation shall be applied around bracket and support rod.

I. Insulation on adjacent piping to flanges shall terminate a sufficient distance back from the flange faces to permit removal of bolts. Terminate by beveling tightly into piping. Flange insulation shall extend along and overlap pipe insulation by at least 2" and shall terminate with a snug fit into pipe insulation with beveled edge. Unions on cold and chilled water shall be insulated in the same manner as flanges. Taper and seal (ground) insulation in continuous runs of vapor sealed pipe at 20 foot intervals, similarly.

J. Any piping exposed in the air stream inside an air handling unit shall be covered with 20 mil PVC jacket pipe covering and sealed watertight in strict accordance with manufacturer's requirements.

K. Insulation shall meet the following fire hazard requirements as tested under procedure ASTM E 84, NFPA 255 and UL 723.

1. Flame spread, less than 25.
2. Smoke developed, less than 50.
3. Fuel Contribution, less than 50.

1.6 ITEMS TO BE INSULATED

A. Domestic hot, cold and recirculating piping

B. Exposed piping (waste, HW and CW) at handicapped sinks. (Provide with PVC jacket).

C. Roof drains and horizontal roof leaders.

1.7 REQUIRED COVERING AND APPLICATION

A. Domestic Hot and Cold Water Piping, Roof Drains, and Roof Leaders. ;

1. Owens-Corning or Johns Manville fiberglass insulation with Type AP all purpose jacket; perm rating of .02 perms. "K" factor of .23 @ 75 degrees mean temperature. Insulation thickness shall be 1", except condensate drains shall be 1/2" thick. Jackets shall be double self-sealing lap (stapled when required) and joints sealed with vapor proof mastic. Wrap joints with J M Dutch Brand

pressure sensitive tape; 2" width. Fittings 2" and larger shall be made of mitered segments of insulation and vapor sealed with (2) coats of vapor barrier adhesive reinforced with glass cloth between coats. Fittings 1 1/2" and smaller shall be wrapped with two (2) coats of vapor barrier adhesive reinforced with glass cloth between coats. In addition to the above in finished areas premolded PVC fittings shall be used. Premold fittings shall be stapled in place, wrapped with 2" wide pressure sensitive tape and the edges sealed with vapor proof mastic.

2. Manufacturers offering products complying with requirements include:

Johns Manville; Glass Fiber with Type AP Jacket

Owens Corning; Fiberglas ASJ/SSL-11 All-Service Jacket

Certain Teed

Knauf

B. Exposed Waste Piping and HW and CW Piping at Handicapped Sinks

1. Piping drops inside walls can be insulated with 1/2" Armstrong Armoflex polyethylene closed cell or equivalent insulation in lieu of 1" fiberglass noted above. Insulation shall be non split type and slipped over pipe before joints are soldered together. All fittings and connections shall be factory pre molded type and applied with factory recommended adhesive. Exposed piping (waste, HW and CW) at handicapped sinks shall have 20 mil PVC jacket (pre-manufactured system can be used at Contractor's option).

C. Domestic Water Below Slab and to 10' 0" Outside Building

1. Piping shall be insulated with 1/2" Armstrong Armoflex polyethylene closed cell or equivalent insulation. Insulation shall be non-split type and slipped over pipe before joints are soldered together. All fittings and connections shall be factory pre-molded type and applied with factory recommended adhesive.

D. NOTE: All areas in the piping system which requires general maintenance (example: valve handles, motorized valve operators, strainers in piping, strainers in suction diffusers, access doors) shall be insulated such that maintenance functions can be made without damaging the insulation.

END OF SECTION 220400

SECTION 220500 - SANITARY SEWAGE DISTRIBUTION SYSTEM

1.1 GENERAL

A. The General Conditions, Special Conditions, and the applicable portions of Division 1 of the Specifications are a part of this Section.

1.2 SCOPE

A. This work includes the furnishing of all labor, materials, equipment, etc., necessary for the proper and complete sanitary sewage distribution system as shown on the Drawings and/or as herein specified in strict accordance with the Kentucky State Plumbing Code and the local utility company.

B. Coordinate with site utility Drawings. See details on drawings.

1.3 EXTERIOR SANITARY SEWER MATERIAL

A. This specification covers Extra Heavy Cast Iron pipe, fittings, and compression gaskets used in sanitary drain, waste and vent (DWV), sewer, and storm drainage applications. This system is intended for use in non-pressure applications.

Pipe and fittings shall comply with ASTM A 74. Compression gaskets shall comply with ASTM C 564. All pipe and fitting shall be made in the United States, and marked with the collective trademark of the Cast Iron Soil Pipe Institute.

Installation shall comply with the latest installation instructions published by Charlotte Pipe and Foundry Company and shall conform to all applicable plumbing, fire, and building code requirements. The system shall be hydrostatically tested after installation to 10 ft. of head (4.3 psi maximum). WARNING! Never test with or transport/store compressed air or gas in Cast Iron pipe or fittings. Doing so can result in explosive failures and cause severe injury or death.

ASTM A 74: Cast Iron Soil Pipe and Fittings, ASTM C 564: Rubber Gaskets for Cast Iron Soil Pipe and Fittings

B. Provide proper fittings for the installation and connection of all lines. In general, provide a Y branch and a 1/8 curve for each branch connection. Provide exterior cleanouts as required and as noted on drawings.

C. All pump discharge sewer piping shall be schedule 80 piping and fittings with solvent welded joints. Piping shall have a 100 psi rating.

D. Provide marker tape as noted in Section 220100.

END OF SECTION 220500

SECTION 220600 - PLUMBING FIXTURES

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 conventional:

1. Plumbing fixtures and related components:

a. Water Closets, wall hung fixture, (WC1)

b. Water Closets, wall hung fixture, (WC1A)

(1) Manual flush valves

(2) Toilet seats

c. Lavatories, wall hung fixture, (L1A)

d. Lavatories, Integral Bowl With Countertop (L2A)

(1) Trim

e. Sink, counter set, stainless steel (S1)

(1) Trim

f. Sink, counter set, stainless steel (S2)

(1) Trim

(2) Dishwasher (DW - provided by owner)

(3) Garbage Disposer (GD-01)

g. Mop Basin (MB1)

(1) Faucet

(2) Accessories

(3) Trim

h. Emergency Eye/Face Wash (EEW)

(1) Thermostatic mixing valve (TMV-2)

i. Electric Water Cooler, (EWC1A)

j. Shower w/ SD-1

(1) (SH1), (SH1A)

k. Floor Drains, Trench Drains, Shower Drains, and Cleanouts

l. Other Specialties

(1) Washer Box, (WB1)

(2) Ice Maker Box, (IMB1)

(3) Hose Bibbs, (HB1, HB2)

(4) Exterior Wall Hydrants, (WH1)

m. Water Hammer Arrestors, (HA)

n. Trap Primers, (TP1, ETP1)

B. Related Sections include the following:

1. Division 10 Section "Toilet, Bath, and Laundry Accessories."

1.3 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.4 SUBMITTALS

A. Shop Drawings: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

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

C. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

C. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures of unit shell.

b. Faulty operation of controls, blowers, pumps, heaters, and timers.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Commercial Applications: One year from date of Substantial Completion.

1.6 OTHER NOTES

A. Provide all plumbing fixtures complete with trim required, and connect in a manner conforming to the state and local plumbing codes. Certain fixtures will be furnished by

others under other sections of the Specifications. Provide rough-in and final connections including all valves, traps, specialties, etc. required.

B. Provide traps for all waste connections where not furnished with the fixture and or equipment; unions; and stops or shut-off valves for all water connections to all sinks and other items of equipment as required. All exposed pipe and metal, including that within cabinets, shall be chrome plated brass.

C. "A" designations indicate ADA compliant fixture.

PART 2 - PRODUCTS

2.1 WATER CLOSETS: WC1, WC1A

A. WC1, WC1A: American Standard 2257.101 Afwall Water Closet

1. Wall Hung, elongated bowl, wall hung, white vitreous china, 1-1/2" top spud, low consumption siphon jet 1.6 gallon per flush.
2. Seat: American Standard 5901 heavy duty, open front seat, less cover
3. Flush Valve: American Standard 6047.121.002 1.28 gallon per flush, manual flush valve
4. Carrier: Provide wall carrier attached to floor. Manufacturers offering carriers complying with requirements include, but not limited to: Zurn, Josam, Smith or equivalent.
5. Mounting Heights:
   a. WC1 – Rim 15"
   b. WC1A – Rim 17"

B. Equivalents:

1. Manufacturers offering water closets complying with requirements include, but not limited to: Toto, Zurn, Kohler. Toto
2. Manufacturers offering Flush Valves complying with requirements include, but not limited to: Sloan, Kohler
3. Manufacturers offering Toilet Seats complying with requirements include, but not limited to: Church, Bemis

2.2 LAVATORIES: L1A, L2A

A. L1A: American Standard 0355.12 Lucerne

1. Wall hung, white vitreous china, with back splash and overflow, 4" faucet centers, with heavy duty steel arm brackets. Install with insulation for exposed supplies and waste for ADA compliance.

B. L2A: Integral Bowl with Countertop

1. Integral with countertop, provided under separate division. Install with insulation for exposed supplies and waste for ADA compliance.

C. Mounting Heights:

   a. L1A – Rim 34"
   b. L2A – Counterset

D. Faucet: American Standard Reliant 3

1. Single lever faucet ADA compliant, chrome plated brass, 4" center set.
2. Chrome plated perforated grid drain, 17 gauge tailpiece, p-trap, and waste Chrome plated brass ½" x 3/8" loose key operated angle stops and supply risers Complete rough-in for supplies, waste and vent, and all final connections.

E. Carrier: Provide wall carrier attached to floor.

F. Equivalents:

1. Manufacturers offering lavatories complying with requirements include, but not limited to: Toto, Zurn
2. Manufacturers offering faucets complying with requirements include, but not limited to: Kohler, Zurn, Moen
3. Manufacturers offering carriers complying with requirements include, but not limited to: Zurn, Josam, Smith or equivalent.

2.3 SINK : S1

A. Single Compartment, Stainless Steel Sink

1. Elkay DLR312212, inside bowl 31"x 22"x 11-5/8" depth, single compartment stainless steel sink, 3-hole punch on 4" centers, 18 gauge 304 stainless, self-rimming. Fully under coated. Provide with 3 1/2" strainer with removable basket, Kentucky Code P-trap, tailpiece, BrassCraft 1/2 screwdriver supplies and stops.
2. Faucet: American Standard 6409.170 swivel gooseneck spout, vandal resistant metal wrist blade handles, 1.5 GPM aerator, LKPDVR18B chrome plated strainer.

B. Equivalents:

1. Manufacturers offering sinks complying with requirements include, but not limited to: Just, Dayton
2. Manufacturers offering faucets complying with requirements include, but not limited to: Kohler, Zurn, Moen

2.4 SINK : S2 with DW and GD1

A. Single Compartment, Stainless Steel Sink with Dishwasher and Disposer

1. Sink same as sink S1.
2. DW: Dishwasher - Provide all rough in and final connections for owner provided dishwasher.
3. GD-01: Insinkerator 3/4 HP Disposer; 120V, single phase.
   a. Syphon Breaker
   b. Dishwasher drain kit
   c. Flow Control Valve
   d. Wall switch
   e. Manual reset

2.5 ELECTRIC WATER COOLER: EWC1A

A. Electric Water Cooler – Wall Mounted, Bi-Level with Bottle Filler

1. Elkay LZSTL8WSSK EZH2O BI-LEVEL ADA electric water cooler with bottle filling station, stainless steel finish, wall mounted drinking fountain. Stainless steel basin with removable drain strainer. Bubbler shall be anti-microbial pliable polyester elastomer. Separate valve and automatic stream regulator shall be mounted within cabinet. Shall have front and side push bar water controls with raised lettering for visually impaired. Cooler shall comply with ANSI 117:1 and ADA for visual and motion disabilities. Provide with 1-1/4" KY Code P-trap and 1/2" water supply and stop.

2. Manufacturers offering products complying with requirements include:

Halsey Taylor, Haws

3. Mounting Heights:

a. Spout: Refer to architectural drawings

2.6 MOP BASIN : MB1

A. FIAT TSB3000 Drop Front Receptor; 24"x24"x12" height.

B. One piece molded tan and white marble chips and white Portland cement ground smooth, grouted and sealed to resist stains.

C. Faucet: American Standard exposed yoke, wall mount utility faucet

1. Mop-Service sink fitting with vacuum breaker, adjustable top brace, ¾" hose thread on spout with bucket hook inlets 8" on center, rough chrome finish.

D. Accessories:

1. FIAT 832AA hose, hanger bracket with clamp.

2. FIAT 889CC mop hanger with three clamps.

3. FIAT MSG wall guards; two 24" panels.

E. Equivalents:

1. Manufacturers offering mop sinks complying with requirements include, but not limited to: Florestone, Stern Williams

2.7 SHOWER: SH1; SH1A

A. SH1: Delta R120SS rough-in valve; T005.501 Shower Trim

1. ASME A112.18.1 pressure balance valve.

2. ASSE 1016 compliant.

3. Single lever handle, ADA compliant.

4. Polished chrome finish.

5. Pressure balance cartridges.

6. Temperature limit stops.

7. Showerhead, arm and flange.

8. Two and one-half (2.5) gpm maximum.

B. SH1A: Delta R10700-UNWS rough-in valve; T13H333 Shower Trim

1. ASME A112.18.1 pressure balance valve.
2. ASSE 1016 compliant.
3. Single lever handle, ADA compliant.
4. Hand shower ADA A117.1 compliant with dual integral check valves in series.
5. Polished chrome finish.
6. Pressure balance cartridges.
7. Temperature limit stops.
8. Integral hot/cold checks.
9. Blue & red visual indicators.
10. Twenty-four inch (24") stainless steel slide bar.
11. Showerhead, arm and flange.
12. Seventy inch (70") long vinyl, nylon reinforced hand shower hose.
13. One and one-half (1.5) gpm maximum.
14. Hand spray with adjustable support.
15. Padded fold up seat (verify orientation).

C. Equivalents:

1. American Standard, Symmons or equivalent.

2.8 FLOOR DRAINS, SHOWER DRAINS, AND CLEANOUTS: FD1, FD2, CO, OR

A. Floor drains shall be equipped with membrane clamping collar and provided with membrane flashing as approved by the state plumbing code. Provide inside caulk type drains for connection to cast iron pipe. Open receptacles (OR) shall be hub of cast iron or PVC pipe set at two (2) inches above finished floor.

B. All interior floor drains and open receptacles shall be furnished with a 1/2" trap primer connection unless otherwise noted.

C. All floor drains and open receptacles shall be provided with trap primers; with no more than four (4) drains served by one (1) trap primer.

D. Where "F" is indicated behind drain number on Drawings, add Z-414 funnel of materials similar to drain top, 4" funnel.

E. First 10' of underslab sanitary of all kitchen floor drains shall be cast iron

F. SD – Shower Drains

1. SD-1 – Josam 30002-5A, 2" outlet, 5" strainer.

G. FD – Floor Drains

1. FD-1 – Josam 30004-6A-49-Y; 4" outlet 5" strainer; ½" tapping for trap primer.
2. FD-2 – Josam 37810-4X-50-84-88; 4" outlet, 12" Heavy duty diameter cast iron; deep sump body; and sediment bucket; and 1/2" tapping for trap primer connection.

H. TRENCH DRAINS TD1:

1. Zurn model Z895 wide reveal trench drain system. Channels shall be 60" long by 12" wide and have a 9-1/8" throat. Modular channel sections shall be of 12GA fabricated stainless steel and have a bolted, flanged connection between channel sections that will not separate during installation. Provide trench model 89502N with the following options:

   a. –U4: 4" no-hub bottom outlet.
   b. –SBG-L: stainless steel bar grate – Class C.
   c. –DB: bottom dome strainer.
   d. –K: anchor flange.

I. CO – Cleanouts:

1. Provide cleanouts in soil, and waste piping at the following locations: base of all stacks, 50' max intervals in horizontal lines, changes in entire system and/or as indicated on the Drawings. Closets or other fixtures shall not be accepted as cleanouts. Cleanouts and/or test tees concealed in inaccessible pipe spaces and walls shall have 8" by 8" access panel. Cover plates and/or access panels shall be set flush with finished floor and walls. Provide membrane clamping collar where applicable.

2. Shall be similar to the following:

   a. Josam 55000-1-Y Series round floor cleanouts, adjustable height, scoriated top, or as applicable.

   b. Josam 58600-CO-VP Series cleanouts tees at base of stacks and at change in direction of lines

   c. Josam 55000-Y adjustable height; with brass tractor grate cover for exterior locations; provide 18"x18"x 4" concrete supporting pad crowned to shed water.

J. OR - Open receptacles

1. Shall be hub of cast iron or PVC pipe set at two (2) inches above finished floor. Provide with ½" trap primers.

K. Access Doors: Zurn model #Z1460-10-VP

1. Square wall access panel and frame, with vandal-proof screws

L. Equivalents:

1. Manufacturers offering mop sinks complying with requirements include, but not limited to: Sioux Chief, Josam, J.R. Smith

2.9 OTHER SPECIALTIES: WB,IMB,HB,WH1,WH2,EEW

A. IMB1 – Ice Maker Box: Guy Gray model #SSMBIBAB

1. Stainless steel with quarter turn ball valve.

B. WB1 - Washer Box: Guy Gray model #82170

1. Stainless steel metal box with center drain with quarter turn ball valves.

C. HB1 – Hose Bibbs : Woodford model #B24P

1. Encased hose bibbs shall have 3/4" hose connection, 1/2" inlet, polished chrome plated brass with integral vacuum breaker; loose key operated; adjustable packing nut with deep stem guard; teflon impregnated packing; mounted at 18" above finish floor.

2. Josam, Zurn or equal.

D. HB2 – Hose Bibbs : Woodford model #24P

1. Exposed hose bibbs shall have 3/4" hose connection, 1/2" inlet, polished chrome plated brass with integral vacuum breaker; metal handle, loose key operated; adjustable packing nut with deep stem guard; teflon impregnated packing; mounted at 18" above finish floor.

2. Josam, Zurn or equal.

E. WH1 – Wall Hydrant : Woodford model #B67 Freezeless Wall Hydrant

1. Excased, non-freeze wall hydrant, with bronze casing, all bronze interior parts, non-freeze operating rod with free floating compression closure valve, replaceable bronze seat and seat washer, complete with operating key.

2. Josam, Zurn or equivalent.

2.10 WATER HAMMER ARRESTORS : HA-xxx

A. HA-*xxx (xxx = Size)*: Zurn model # Z1700 "Shoktrol"

1. Bellows or piston type with pressurized cushioning chamber. Sizes are based on water-supply fixture units

B. Equivalents:

1. Manufacturers offering Water Hammer Arrestors complying with requirements include, but not limited to: Sioux Chief, Watts, Smith

2.11 TRAP PRIMERS: TP1, ETP1

A. TP1 – Trap Primer: Precision Plumbing Products model # PR-500

1. Flow sensing trap primer, ½" inlet, low lead. All floor drains and open receptacles get trap primers. Needs to be accessible.

B. ETP1 – Electronic Trap Primer: Precision Plumbing Products model # PTS-10

1. Compression fittings
2. 16 ga. Steel cabinet
3. Stainless steel access door for drywall installation
4. Cylinder lock
5. Anti-syphon backflow preventer
6. 12 – ½" outlets

PART 3 - EXECUTION

3.1 EXAMINATION

A Examine roughing-in for potable, hot- and cold-water supply piping systems; soil, waste, and vent piping systems; and supports. Verify that locations and sizes of piping and loca-

tions and types of supports match those indicated, before installing and connecting fixtures. Use manufacturer's roughing-in data when roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Domestic Cold Water, Piping, Valves and Fittings. Refer to Section 15250 Mechanical Insulation for plumbing insulation requirements.

3.3 PLUMBING FIXTURE INSTALLATION

A. Assemble plumbing fixtures and trim, fittings, faucets, and other components according to manufacturers' written instructions.

B. Install fixtures level and plumb according to manufacturers' written instructions, roughing-in drawings, and referenced standards.

C. Install floor-mounted, back-outlet water closets with fittings and gasket seals.

D. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gage.

E. Install toilet seats on water closets.

F. Install wall-hanging, back-outlet urinals with gasket seals.

G. Install flush valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for handicapped people to reach.

H. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.

I. Fasten recessed, wall-mounted fittings to reinforcement built into walls.

J. Fasten wall-mounted fittings to reinforcement built into walls.

K. Fasten counter-mounting plumbing fixtures to casework.

L. Secure supplies to supports or substrate within pipe space behind fixture.

M. Set shower receptors and mop basins in leveling bed of cement grout as specified by Architect.

N. Install individual stop valve in each water supply to fixture. Use gate or globe valve where specific stop valve is not specified.

1. Exception: Omit stop valves on supplies to emergency equipment, except when permitted by authorities having jurisdiction. When permitted, install valve chained and locked in OPEN position.

O. Install water-supply stop valves in accessible locations.

P. Install faucet, laminar-flow fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.

Q. Install supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.

R. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.

S. Install shower, flow-control fittings with specified maximum flow rates in shower arms.

T. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes, except where otherwise indicated.

U. Install disposers in sink outlets. Install switch where indicated, or in wall adjacent to sink if location is not indicated.

V. Install trap primers and trap primer distribution units in accessible locations. If installed in walls, above hard ceilings, etc. provide access panel, minimum 12"x12" in size.

W. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

X. Seal joints between fixtures and walls, floors, and counters using sanitary-type, 1-part, mildew-resistant, silicone sealant. Coordinate this requirement with Architectural trades.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other Division 15 Sections.

2. All floor drains, floor sinks, and open receptacles shall have trap primer connections.

B. Supply and Waste Connections to Plumbing Fixtures: Refer to plumbing fixture schedules for fitting sizes and connection requirements for each plumbing fixture.

C. Supply and Waste Connections to Equipment Specified in Other Sections: Connect equipment with supply inlets, supply stops, supply risers, and traps specified in this Section. Use fitting sizes required to match connected equipment. Connect fittings to plumbing piping.

D. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Arrange for electric-power connections to fixtures and devices that require power. Electric power is specified in Division 16 Sections and individual equipment sections.

3.5 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized and demonstrate proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Verify proper operation of trap primers.

3.6 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers, hot-water dispensers, and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at drinking fountains, electric water coolers, faucets, shower valves, trap primers and flushometer valves having controls, to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Include the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.

2. Remove sediment and debris from drains.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities, except when approved in writing by Owner.

END OF SECTION 220600

SECTION 220700 - MISCELLANEOUS PLUMBING 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. This Section includes the following miscellaneous plumbing equipment:

1. Gas Water Heater
2. Pumps
   a. Domestic Water Recirculation Pumps
   b. Sump Pump
3. Mixing Valves
   a. Thermostatic Mixing Valves
4. Expansion Tanks
5. Backflow Preventer
6. Oil/Water Sperarator

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings for each of the following plumbing miscellaneous items.
   a. Gas Water Heater
      (1) Water Heater
   b. Pumps
      (1) Domestic Water Recirculation Pumps
      (2) Sump Pump
   c. Mixing Valves
      (1) Thermostatic Mixing Valves
   d. Expansion Tanks
   e. Backflow Preventer
      (1) Backflow Preventer
   f. Oil/Water Separator
      (1) Oil/Water Separator
2. Product Data: For each plumbing specialty indicated. Include rated capacities of selected equipment and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following plumbing specialty products:

B. Operation and Maintenance Data:

C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, dimensional requirements, and characteristics of plumbing specialties and are based on the specific types and models indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

C. 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.

D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/ IESNA 90.1-2004.

E. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

B. Coordinate locations of all plumbing equipment with all other trades prior to installation. Notify engineer of any conflicts'

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.

b. Faulty operation of controls.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period(s): From date of Substantial Completion:

a. Gas Water Heaters:

(1) Controls and Other Components: 3 years.

1.7 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents

1. One (1) complete set of replacement elements for all water heaters.

2. Three (3) flush valve repair kits for both water closets and urinals.

3. Repair kits for each mixing valve.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 GAS WATER HEATER: GWH-01, GWH-02, GWH-03, GWH-04

A. GWH-01, -02, -03, -04: AO Smith model # ATI-540-H Commercial Gas Tankless Water Heater

1. Ultra-low NOx tankless water heater condensing technology with 0.95 energy factor. 199,000 BTU input, natural gas. Continuous maximum flow rates up to 10 gpm, integrated temperature controls, and advanced diagnostics. Easy link units with common vent. ¾" npt hot, cold and gas connections.

2. Install all vent piping per manufacturer's recommendations.

B. Equivalents:

1. Manufacturers offering Water Heaters complying with requirements include: Rheem, Rinnai

2.3 PUMPS: RP-1

A. RP-01 : Wilo model STAR 32 BF.

1. Recirculation Pumps shall be designed for continuous operation, bronze construction, provided with thermal overload protection and shall be supported by the water piping. Control of the hot water recirculating pumps shall be by means of an immersion adjustable range aquastat with visible scale and detachable well.

B. SP-01: Zoeller model # N152

1. Sump pump rated for 61 GPM, 10 feet of head, 1/2 HP, 3450 RPM, 115V/1PH/60Hz, 15 amps, double seal series with 20' cord, 1-1/2" NPT discharge.

C. SP-02: Zoeller model # N152

1. Sump pump rated for 61 GPM, 10 feet of head, 1/2 HP, 3450 RPM, 115V/1PH/60Hz, 15 amps, double seal series with 20' cord, 1-1/2" NPT discharge.

D. See pump schedule and details herein and on Drawings for locations and capacities

E. Equivalents:

1. Manufacturers offering Recirculation Pumps equal to and complying with requirements, but not limited to: Zoeller, Grundfos, Armstrong

2. Manufacturers offering Sump Pumps equal to, but not limited to: Weil, Myers

2.4 MIXING VALVES: TMV-1, TMV-2

A. TMV-1: Acorn MV17-5

B. TMV-2: Bradley S19-2000 EFX8

C. The Contractor shall also provide field installed check valves and shut-off valves and thermometer, 0-150 deg. F range. Locate assembly for easy access and adjustment.

D. See Schedule and Details herein and on Drawing for capacities and locations

E. Equivalents:

1. Manufacturers offering Mixing Valves complying with requirements include: Bradley, Acorn, Symmons, Lawler, Powers

2.5 EXPANSION TANKS : ET-1

A. ET-1 : Amtrol model # ST-20VC

1. Serving GWH-01, -02, -03, -04

B. Set tank to operate at building water pressure. Tanks shall have butyl diaphragm.

C. See Schedule and Details herein and on Drawing for capacities and locations.

D. Equivalents:

1. Manufacturers offering Expansion Tanks complying with requirements include, but not limited to: B & G, Taco, Watts

2.6 BACKFLOW PREVENTER

A. Ames Maxim Series model #M400 with wye strainer on inlet, OS&Y gate valves or equal.

2.7 OIL/WATER SEPARATOR: OWS1 Schier Model OS-50

A. Reference the detail for more information.

B. 50 GPM flow rate; 52 gallon volume capacity; 34.1 gallons of oil; highway rated cover; adjustable extension risers

2.8 SOURCE QUALITY CONTROL

A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 - EXECUTION

3.1 PLUMBING SPECIALTY INSTALLATION

A. General: Install plumbing specialty components, connections, and devices according to manufacturer's written instructions.

B. Install backflow preventers of type, size, and capacity indicated, at each water-supply connection to mechanical equipment and systems, and to other equipment and water systems as indicated. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment. Install air-gap fitting on units with atmospheric-vent connection and pipe relief outlet drain to nearest floor drain. Do not install bypass around backflow preventer.

C. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.

D. Install hose bibbs with integral or field-installed vacuum breaker.

E. Install wall hydrants with integral or field-installed vacuum breaker.

F. Install trap seal primer valves with valve outlet piping pitched down toward drain trap a minimum of one percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

G. Install expansion joints on vertical risers, stacks, and conductors as indicated.

H. Install cleanouts in aboveground piping and building drain piping as indicated, and where not indicated, according to the following:

1. Size same as drainage piping up to 4-inch NPS (DN100). Use 4-inch NPS (DN100) for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet (15 m) for piping 4-inch NPS (DN100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

I. Install cleanout deck plates, of types indicated, with top flush with finished floor, for floor cleanouts for piping below floors.

J. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.

K. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

L. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.

M. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

N. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor or as indicated. Size outlets as indicated.

O. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

1. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
2. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to one percent slope.
3. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.

P. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

Q. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

R. Position floor drains for easy access and maintenance.

S. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.

T. Fasten recessed, wall-mounting plumbing specialties to reinforcement built into walls.

U. Secure supplies to supports or substrate.

V. Install individual stop valve in each water supply to plumbing specialties. Use ball, valve if specific valve is not indicated.

W. Install water-supply stop valves in accessible locations.

X. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

Y. Locate drainage piping as close as possible to bottom of floor slab supporting fixtures and drains.

Z. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

AA. Include wood-blocking reinforcement for recessed and wall-mounting plumbing specialties.

3.2 CONNECTIONS

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

1. Install piping connections between plumbing specialties and piping specified in other Division 22 Sections.

2. Install piping connections indicated between appliances and equipment specified in other Sections; connect directly to plumbing piping systems.

3. Install piping connections indicated as indirect wastes from appliances and equipment specified in other Sections, to spill over receptors connected to plumbing piping systems.

4. Supply Runouts to Plumbing Specialties: Install hot- and cold-water-supply piping of sizes indicated, but not smaller than required by authorities having jurisdiction.

5. Drainage Runouts to Plumbing Specialties: Install drainage and vent piping, with approved trap, of sizes indicated, but not smaller than required by authorities having jurisdiction.

3.3 FLASHING INSTALLATION

A. Fabricate flashing manufactured from single piece unless large pans, sumps, or other drainage shapes are required. Coordinate ALL flashing with Architect.

B. Burn joints of lead sheets where required.

C. Solder joints of copper sheets where required.

D. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane. Coordinate with Architect.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (2500 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.
4. Coordinate all roof penetrations and roof flashings with roof manufacturer.

E. Set flashing on floors and roofs in solid coating of bituminous cement; as directed by Architect.

F. Secure flashing into sleeve and specialty clamping ring or device.

G. Install flashing for piping passing through roofs with counter flashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."

H. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

I. Fabricate and install flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection if indicated.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of factory-authorized service representative to supervise the field assembly of components and installation of grease recovery units, including piping and electrical connections, and to report results in writing.

1. Test and adjust plumbing specialty controls and safeties. Replace damaged and malfunctioning controls and components.

3.5 COMMISSIONING

A. Before startup, perform the following checks:

1. System tests are complete.
2. Damaged and defective specialties and accessories have been replaced or repaired.
3. Clear space is provided for servicing specialties.

B. Before operating systems, perform the following steps:

1. Close drain valves, hydrants, and hose bibbs.
2. Open general-duty valves to fully open position.
3. Remove and clean strainers.
4. Verify that drainage and vent piping are clear of obstructions. Flush with water until clear.

C. Startup Procedures: Follow manufacturer's written instructions. If no procedures are prescribed by manufacturer, proceed as follows:

1. Energize circuits for electrically operated units. Start and run units through complete sequence of operations.

D. Adjust operation and correct deficiencies discovered during commissioning.

3.6 PROTECTION

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

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

END OF SECTION 220700

SECTION 220700.1 – PREVENTATIVE MAINTENANCE FOR PLUMBING EQUIPMENT

1.1 GENERAL

A. The General Conditions and Special Conditions and all other Contract Documents shall apply to this Division of the work as well as to all other Divisions.

1.2 SCOPE

A. This Section details the requirements for the Plumbing Contractor to perform scheduled preventative maintenance (PM) on the entire plumbing system, including the following plumbing equipment:

1. Gas fired water heaters
2. Domestic hot water recirculation pumps
3. Trap primers
4. Oil/Water Separators

B. The plumbing system consist of domestic cold, hot, hot recirculation water including sanitary sewer piping with gas fired water heaters, hot water recirculation pumps and oil/water separator.

C. All work for this project must comply and be in strict accordance with the Kentucky Building Code, Kentucky Plumbing Code, Kentucky Boiler Code, IMC 2012, NFPA, ADA, NEC and all local codes and regulations.

D. Preventative maintenance shall be performed to verify that equipment has been installed and continues to operate in strict accordance with manufacturer's requirements.

E. In addition to inspecting items as listed below, the Mechanical Contractor shall correct any and all deficiencies found in accordance with the first year parts and labor warranty.

1.3 DESCRIPTION OF SERVICES FOR GAS FIRED WATER HEATERS

A. Four (4) times within the first full year following date of substantial completion, a thorough preventative maintenance schedule will be performed including the following:

1. General
    a. Check gas supply.
    b. Check inlet cold water temperature.
    c. Check outlet hot water temperature.
    d. Check return hot water recirculation temperature.
    e. Check operation of control circuit.
    f. Test safeties and pressure relief valve.
2. Controls and Safeties
    a. Inspect controls prior to startup.
    b. Check settings of all safety devices.
    c. Check operation of the control system while in operation.

1.4 DESCRIPTION OF SERVICES FOR DOMESTIC HOT WATER RECIRCULATION PUMPS

A. Four (4) times within the first full year following date of substantial completion, a thorough preventative maintenance schedule will be performed including the following:

1. General

a. Check voltage supplied to pump.

b. Check correct rotation of pump.

c. Check operation of check valves.

d. Check aquastats, contactors and relays for proper operation.

e. Check wiring integrity (terminal tightness).

f. Check water return temperatures, compare to start-up log.

1.5 DESCRIPTION OF SERVICES FOR TRAP PRIMERS

A. Four (4) times within the first full year following date of substantial completion, a thorough preventative maintenance schedule will be performed including the following:

1. General

a. Verify operation.

b. Verify water is supplied to all connected drains.

1.6 DESCRIPTION OF SERVICES FOR OIL/WATER SEPERATOR

A. Annual calibration service – One (1) year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

1. Outdoor Unit

a. Inspect all cover gaskets to verify water and airtight.

b. Check unit for sand retention level, compare to previous log.

c. Check unit for oil retention level, compare to previous log.

1.7 SUBMITTALS

A. Provide a written report of completed work, operating log, and indicate any uncorrected or corrected deficiencies detected.

B. At date of substantial completion, provide Owner with a comprehensive Preventative Maintenance (PM) Schedule for the upcoming year for their review and acceptance. Contractor is responsible for notifying the Owner of upcoming service days and coordinate with the Owner's schedule as required.

END OF SECTION 220700.1

SECTION 220750 – ROOF DRAINAGE SYSTEMS

1.1 GENERAL

A. The building roof drainage system shall be installed as shown on the Drawings. Drainage system shall include all pipe, fittings, roof drains, and all appurtenances necessary for roof drainage system to 5'-0" outside of building. See Utility Site Plans for exact locations. Coordinate all invert elevations prior to construction. See architectural plans for down spout boot locations and requirements.

1.2 ROOF DRAINS

A. ROOF DRAINS: RD1

1. Froet series 100-LP-DMP low profile combination primary / overflow roof drain. Painted cast iron with flange, combination membrane flashing clamp / gravel guard, medium sump body, cast iron mushroom dome, no-hub dual bottom outlets, adjustable drain riser, bearing pan with securing package.

B. Equivalents:

1. Josam, Ancon or Wade

1.3 DOWNSPOUT NOZZLE: DSN1

A. Wade model 3940-NH. Inlet size as shown on plans; all nickel bronze body; no-hub outlet; PVC connection; removable stainless steel screen.

1.4 FLASHING

A. All roof drains shall be flashed by Roofing Contractor. Coordinate locations and sizes with roofing manufacturer.

1.5 DOWN SPOUT BOOTS

A. Provided by others. See architectural drawings.

1.6 ROOF LEADER & SECONDARY DRAINAGE SYSTEM PIPING

A. Above Ground – Interior Piping: Roof leader piping and fittings installed above grade shall be hub and spigot or no-hub service weight cast iron pipe and fittings. Piping shall be insulated and installed on hangers with insulation guards and supports. Hanger spacing for piping shall be in accordance with all state and local plumbing codes, and the pipe manufacturer's requirements. See detail on drawings.

B. Under Ground – Interior & Exterior Piping: Roof leader piping and fittings installed below grade shall be solid core PVC SDR-17 (equivalent to schedule 40 pipe). Piping and fittings shall have factory installed lock-in rubber "O" rings / gaskets. Piping installed outside building shall have a minimum cover of 18".

1.7 ROOF LEADER INSULATION (Interior above grade)

A. All interior roof leader piping shall be insulated with 1" of fiberglass pipe insulation and covered with all service jacketing. Refer to specification section 220400 - Plumbing Insulation

B. See detail on drawings.

END OF SECTION 220750

SECTION 220800 - COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Owner's Project Requirements and Systems Basis of Design documentation are included by reference.

C. Commissioning Plan and Appendices.

1.02 SUMMARY

A. Section includes commissioning process requirements for Plumbing Systems, assemblies, and equipment.

B. Related Sections:

1. Section 017900 – Demonstration and Training
2. Section 019113 - General Commissioning Requirements
3. Section 019113.13 – Functional Testing
4. Division 22 Sections for plumbing equipment and assemblies.

1.03 SYSTEMS COMMISSIONED

A. Equipment list:

1. Gas Water Heaters
2. Thermostatic Mixing Valve
3. Expansion Tank
4. Trap Primer
5. Recirculating Pump
6. Sump/Dewatering Pump
7. Oil/Water Separator

1.04 CONTRACTOR'S RESPONSIBILITIES

A. Attend Construction Phase Commissioning Conference.

B. Satisfy applicable project Owner's Project Requirements.

C. Review the Commissioning Plan prepared by Commissioning Authority.

D. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.

E. Cooperate with the Commissioning Authority for resolution of issues recorded in the Issues Tracking Log. Resolution will occur within one week of finding and notification.

F. Attend Commissioning Team Meetings held on a bi-weekly basis.

G. Integrate and coordinate commissioning process activities with Construction Schedule.

H. Review, accept, and support execution of Construction Checklists provided by the Commissioning Authority.

I. Support completion of Construction Checklists as Work is completed.

J. Review and accept Functional Test Procedures provided by the Commissioning Authority.

K. Support completion of Functional Test Procedures, including seasonal and any deferred test procedures.

L. Provide Owner training as directed in equipment specification sections and Section 017900.

M. Provide O&M Manuals as required by the A/E.

N. Provide project specific close-out documents as required for the systems manual per LEED EAc3: Enhanced Commissioning.

O. Provide access to electrical, water, scaffolding, man-lifts, of other mechanical conveyances used by the contractors to perform their work during functional and performance testing under the direction of the CA. If mechanical conveyances are unavailable during the commissioning process, the Construction Manager will provide the necessary equipment for access required.

1.05 COMMISSIONING AUTHORITY'S RESPONSIBILITIES

A. See specification section 019113, 1.07 'Commissioning Authority's Responsibilities'

1.06 COMMISSIONING SUBMITTALS

A. Equipment submittals for commissioned systems, assemblies, equipment, and components will be reviewed by the Commissioning Authority as part of the normal submission procedure.

B. All testing plans and schedules to be reviewed and approved by Commissioning Authority as indicated in this Section and the Commissioning Plan.

1.07 COMMISSIONING DOCUMENTATION

A. Contractor shall provide the following information to the Commissioning Authority during the commissioning process for inclusion in the Commissioning Plan:

1. Process and schedule for supporting completion of Construction Checklists for Plumbing Systems, assemblies, equipment, and components to be verified and tested.
2. Support completion of Construction Checklists for review and approval by Commissioning Authority and Architect / Engineer.

B. In addition to the requirements detailed in applicable Division 22 sections, the Contractor shall provide the following information, in electronic form, to the Architect / Engineer for inclusion in the Commissioning Report:

1. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
2. Test and inspection reports and certificates.
3. Completed Functional Test procedures.
4. Response to corrective action documents.
5. A record of Owner training sessions.

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.01 CONSTRUCTION CHECKLISTS PREPARATION

A. Refer to Section 019113 - General Commissioning Requirements for complete procedures and requirements.

3.02 CONSTRUCTION CHECKLISTS EXECUTION

Refer to Section 019113 - General Commissioning Requirements for complete procedures and requirements.

3.03 FUNCTIONAL TEST PREPARATION

A. Refer to Section 019113.13 – Functional Testing for complete procedures and requirements.

3.04 GENERAL FUNCTIONAL TESTING REQUIREMENTS

A. Refer to Section 019113.13 – Functional Testing for complete procedures and requirements.

3.05 FUNCTIONAL TEST EXECUTION

A. Refer to Section 019113.13 – Functional Testing for description of tasks to complete for this project.

3.06 POST ACCEPTANCE PERIOD

A. Refer to Section 019113.13 – Functional Testing for complete seasonal or deferred testing procedures and requirements.

3.07 OWNER TRAINING

A. Refer to Section 017900 – Demonstration and Training for Owner Training requirements for this project.

END OF SECTION 220800

SECTION 230510 - GENERAL PROVISIONS FOR HVAC

1.1 GENERAL

A. The General Conditions and Special Conditions and all other Contract Documents shall apply to this Division of the work as well as to all other Divisions.

1.2 SCOPE

A. This branch of the work includes coordination with all utility companies; agency review fees and all inspection fees; all labor, materials, tools, excavation and backfill and all equipment necessary for the installation of all Heating, Ventilating and Air Conditioning, System as shown on the Drawings and Specifications and/or as required for complete and operating systems. The work shall include starting, balancing and the necessary and required tests to insure the proper operation of the complete system.

B. The HVAC system design shall be an air-source Variable Refrigerant Flow (VRF) Heat Recovery system with a rooftop Energy Recovery Unit (ERU).

C. All work for this project must comply and be in strict accordance with the Kentucky Building Code, Kentucky Plumbing Code, Kentucky Boiler Code, IMC 2012, NFPA, ADA, NEC and all local codes and regulations.

D. In general (as a minimum) all materials and equipment must be installed in strict accordance with manufacturer's requirements; and provided with all required controls, internal fusing, relays, piping connections, electrical connections, ductwork connections, etc., to provide for complete and operable systems.

E. Mechanical Contractor shall be responsible to comply with requirements of specifications section 013100 - PROJECT MANAGEMENT AND COORDINATION.

1.3 PERMITS, CODES, AND APPROVALS

A. Permits and Fees

1. All permits, tap on fees and agency review and inspection fees necessary for the complete HVAC, system shall be obtained by the Contractor from the authorities governing such work. The cost of all permits shall be borne by the Contractor.

B. Codes

1. The minimum standard for all plumbing work shall be the requirements of the Kentucky State Plumbing Law, Regulation and Code, Kentucky Building Code, ADA, The Division of Water Quality and local ordinances. HVAC and Exhaust systems and all mechanical, plumbing, fire protection and electrical work for this project must as a minimum comply and be in strict accordance with the Kentucky Building Code, Kentucky Plumbing Code, Kentucky Boiler Code, International Mechanical Code (2012), NFPA, ADA, NEC, The Division of Water Quality and the "Standards of Safety" of the Commonwealth of Kentucky.

C. Approvals

1. All work must be approved by the Architect/Engineer, Owner and all related Code Agencies before final payment will be made.

2. As a minimum, the following approval Certificates of Inspection and Approval shall be required:

a. HVAC Inspection

b. Plumbing Inspection

c. Fire Protection Inspection

d. Health Department Inspection

e. Electrical Inspection

f. Local and Stage Building Inspections.

3. Final payment will be contingent upon all Approval Certificates.

1.4 MECHANICAL DRAWINGS AND SPECIFICATIONS

A. The Drawings and Specifications are intended to cover all work enumerated under the respective headings. The Drawings are diagrammatic only as far as final location of pipes, ducts relative size, etc., is concerned. Any item of work not clearly included, specified and/or shown, errors or conflict between Plans (Mechanical, Architectural, Structural or Electrical), Specifications, codes and field conditions, shall be clarified by a written request to the Architect by the Bidder before bidding; otherwise, the bidder shall, at his own expense, supply the proper labor and materials to include these items of work and to make good any damages or defects in his work caused by such error, omission or conflict. Under no circumstances shall a Contractor scale the Drawings for the location of equipment and work.

B. Piping schematics, risers, motors and details shown on the Drawings are for the equipment specified hereinafter. All revisions, modifications or changes in piping, accessories etc., due to using equipment of a different manufacturer than specified hereinafter, shall be the responsibility of the bidder and shall be made at no additional cost to the Owner. All modifications or changes shall be submitted to the Architect in writing and meet with his approval before the equipment is released for shipment.

C. The Contractor shall be responsible for all revisions, modifications or changes necessary in the structural, architectural or electrical drawings and/or work to accommodate the equipment to be furnished under this section of the Specifications. This shall be made at no additional cost to the Owner.

D. Mechanical as built "Record Drawings" shall be kept up to date each day. "Record Drawings" shall be reviewed by Architect/Engineer each month with contractor's pay request review.

E. Any deviation in work as shown on plans and specifications must be approved in writing by Architect/Engineer prior to installation.

F. The mechanical contractor shall be responsible for contributing to the coordination drawing set and notify the Mechanical Engineer of any conflicts with other disciplines, prior to construction.

1.5 MATERIAL AND WORKMANSHIP

A. Material and workmanship shall comply with the General Conditions of these Specifications.

B. All material and equipment and locations of same shall at least conform with the standards of the Underwriters' Laboratories, Inc., whenever applicable.

1.6 ACCESSIBILITY

A. All equipment, valves, motors, damper operators, traps, unions and all other items which require adjustment, maintenance, repair and observation shall be installed in such a

fashion that such maintenance, repair and observation can be readily achieved without undue difficulty including complete removal of heat pump units. Where the drawings show these items in locations not conforming to the above, the Contractor shall advise the Architect/Engineer of this conflict prior to bid Date otherwise he shall, at his own expense, relocate such items as directed by the Architect/Engineer. Where such items are installed above inaccessible ceilings or in or behind walls, this contractor shall provide approved access panels unless otherwise directed in these Specifications.

1.7 ARCHITECTURAL DRAWINGS AND SPECIFICATIONS

A. Each Contractor shall refer to the Architectural and Structural Drawings and Specifications for the general construction of the building, for floor and ceiling heights, for location of walls, partitions, beams etc., and shall be guided accordingly for the setting of all sleeves and equipment.

B. Under no circumstances shall a Contractor scale the Drawings for the locations of equipment and work.

1.8 COOPERATION WITH OTHER CONTRACTORS

A. Each Contractor shall demand and examine all Drawings and Specifications pertaining to the construction before installing the work described and shown under these Drawings and Specifications. Each Contractor shall cooperate with all other contractors in locating piping, openings, chases and equipment in order to avoid conflict with any other contractor's work. It is the responsibility of all trades to examine all shop drawings of other trades that would require equipment to occupy the same space and plane within the building to eliminate any potential conflicts. No extra payment will be allowed for relocation of piping, ductwork, and equipment not installed in accordance with the above instructions, and which interferes with work and equipment of other contractors.

B. Mechanical Contractor shall be responsible to comply with requirements of specifications section 013100 - PROJECT MANAGEMENT AND COORDINATION.

1.9 INSTALLATION OF EQUIPMENT

A. All appliances, materials and equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations. All auxiliary piping, special controls, water seals, valves, electrical connections, drains, etc., recommended by the manufacturer, required for proper operation, or required by code shall be furnished and installed complete.

B. All equipment designed and constructed for indoor use shall not be shipped to the site until such time that the equipment is ready for permanent installation in a dry building or may be stored on site provided equipment is stored in a water and moisture tight storage building or job trailer. Covering equipment outdoors with plastic or tarp is not acceptable.

1.10 PROTECTION

A. No piping shall be installed in any part of the building where danger of freezing may exist without adequate protection being given, whether or not insulation is specified for the particular piping. All damage resulting from leaking pipes shall be borne by the Contractor under this Division.

B. All work, equipment and materials shall be protected at all times. All pipe openings shall be closed with caps or plugs during construction. All equipment and accessories shall be

tightly covered and protected against dirt, water or other injury during the period of construction.

C. If the permanent HVAC equipment is used during construction period for temporary heating, cooling and ventilating, the equipment must be carefully protected, and filters changes at minimum of once a week. All return air and exhaust air ductwork used in temporary HVAC systems during construction period must be filtered at each opening to prevent construction dust from entering the ductwork system.

D. Before the building is turned over to the Owner all of the equipment must be carefully cleaned of debris and dust, coils cleaned and flushed out, new filters installed, and all ductwork cleaned of debris and dust.

1.11 AIR FILTERS

A. At a minimum, all pieces of equipment shall be provided with 1", 30% filters to filter all return air prior to passing over the unit coil. Refer to equipment specification for additional requirements.

B. Contractor shall perform filter change on all equipment and air devices upon project substantial completion.

C. As part of Preventative Maintenance (PM), the Contractor is required to change air filters for all mechanical equipment for the first full year of occupancy. Upon completion of first full year, Contractor shall provide one (1) spare set of filters for the entire project, and place them in the mechanical room for Owner's use. VRF Indoor units shall receive a total of two (2) washable filter sets for all indoor units. Refer to Specification Section 238146.1 for additional PM requirements.

1.12 OPENINGS AND ESCUTCHEONS

A. The Contractor under this Division shall be responsible for the openings he may require in floors, walls or ceilings of any type construction whether or not shown on the Architectural and/or Structural Drawings.

B. Openings that have been shown on the Architectural and/or Structural Drawings will be provided under other Divisions; however, the responsibility for the correct size and location of such openings shall be that of the Contractor under this Division.

C. Openings that have not been shown on the Architectural and/or Structural Drawings shall be provided by the Contractor under this Division as follows:

1. Passages for pipe through masonry and concrete walls and floors shall be by means of standard weight steel pipe sleeves. With the approval of the Architect, holes may be cut and sleeves may be omitted in areas having thin or lightweight construction. Holes shall be cut by means of rotating drill bits or saws, producing a neat and accurate fit for the pipes. No hammer devices will be permitted. Such holes shall be not more than one half inch (1/2") greater in diameter than the external diameter of the pipe. Cutting of holes in structural slabs or members will not be permitted without approval of the Architect/Engineer.

2. Openings for insulated piping such as heating, domestic hot and cold water, etc., shall be of sufficient size to allow the insulation to pass through uninterrupted with the piping.

3. Cast iron sleeves shall be installed through walls where pipes enter the building below grade and at all fire rated assemblies. Sleeves shall be flush with each face

of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking with lead and oakum between pipe and sleeve for waterproofing.

4. Openings for ductwork fixtures, equipment, etc., through floors, walls or ceilings, shall be located and sized by the Contractor under this Division who shall provide and set necessary sleeves or sheet metal forms for all such openings through concrete walls, floors or the roof slab. For openings required through ceilings, walls or roof construction, the Contractor under this Division shall furnish and install all necessary frames, supports, lintels, etc., required for the openings, such as plaster frames for registers and recessed equipment frames.

D. Smoke and Firestopping

1. Shall be provided between ductwork and its opening through all walls, floors and partitions. Firestopping shall be provided between sleeves and piping which pass through walls, floors or partitions. This contractor shall furnish and install fire protection sealant where pipes pass through fire rated walls, partitions, ceilings or floors. The fire rated integrity of the assemblies must be maintained.

2. The materials used shall be UL 263 and UL 1479 classified and meet ASTM E814 standards and be rated for assemblies where applied. Material shall be installed in strict accordance with manufacturer's recommendations and published literature.

3. Furnish and install 3M "Interam Fire Protection Systems", DOW CORNING or Hilti "Fire Stop" System.

E. All exposed piping passing through floors, ceilings and walls in finished areas shall be fitted with a chrome plated escutcheon of sufficient outside diameter to amply cover the sleeved opening and an inside diameter to closely fit the pipe around which it is installed.

F. Galvanized sheet metal collars shall be provided around all ducts, equipment, etc., exposed in finished areas. Where such openings are finished and the space around the unit is small, the collar may be omitted with the approval of the Architect.

1.13 CUTTING AND PATCHING

A. No cutting and patching of new finished work will be permitted without the approval of the Architect, and such work shall be done only under his direction. Coordinate all openings with Architectural specifications.

B. All work improperly done or not done at all, as required in preceding article "Openings and Escutcheons", will be performed as directed by the Architect/Engineer and at the expense of the Contractor whose work is affected.

1.14 SERVICE AND GUARANTEE

A. Contractor shall be responsible for guaranteeing all work, including equipment, materials and workmanship furnished under this section of the Specifications. HVAC equipment and services warranty shall be provided for a period of one (1) year from the date of substantial completion, in addition to the Preventative Maintenance contract for the first year of occupancy. Refer to Specification Section 238146.1 for additional information regarding first year Preventative Maintenance.

B. The warranty created by Article 3.5 of the General Conditions remains enforceable throughout the period of the Kentucky statute of limitations. The Warranty is different from the one-year correction period defined in General Conditions Article 12.2.2. except

for items of equipment requiring explicit extended warranties, refer the Bidder/Contractor to General Conditions Articles 3.5 and 12.2.2 for warranty and correction of work.

C. Any defective work, equipment, materials and/or workmanship that develops within the guarantee period, which is not caused by ordinary wear, damage or abuse by others, shall be replaced and/or corrected without additional cost to the Owner.

D. Make a minimum of two (2) service calls during guarantee period, free of charge, to check with Owner and to check and repair malfunctioning equipment which was installed. Service calls shall be in middle and end of guarantee period and as required to maintain systems operation. Dates shall be listed in operating and maintenance manuals, along with contractor's name and phone number.

E. Contractor shall provide Preventative Maintenance, including filter changes and chemical treatment for hydronic loop per manufacturer's recommendations for a period of one (1) year from substantial completion. Refer to Specification Section 238146.1 for additional information regarding Preventative Maintenance.

1.15 SHOP DRAWINGS

A. Each Shop Drawing and/or manufacturer's descriptive literature shall have the project name indicated thereon and shall be clearly referenced to the specification, section number, schedule, material, etc., so the Engineer may readily determine the particular item the Contractor or subcontractor proposes to furnish. Each submission shall also contain Date Submitted. If Shop Drawings and/or other items are transmitted by correspondence, each item of correspondence shall bear project name. If transmitted by hard copy, the shop drawings shall be submitted in ACCO Model 25071 Series binders with Presstex covers. At the Engineer's discretion, the Contractor shall submit additional shop drawings as deemed necessary.

B. The Mechanical Contractor must carefully review and stamp all shop drawings before submitting to Architect/Engineer. The Contractor must verify all quantities, sizes, left and right-hand connections, access door locations, horsepower, voltage, ensure adequate clearance for installation and service, etc.

C. The Mechanical Contractor must coordinate all submittals with the Electrical Contractor to insure proper clearances with electrical equipment and to insure that all equipment with electrical connections are being submitted with proper voltage, proper left and right-hand electrical connections, proper relays, proper contactors, proper starters, etc.

D. Electronic shop drawings are permitted.

E. Descriptive literature and Schedules shall be submitted as a minimum (but not limited to) the following:

Valves	Electric Ceiling Heaters	Variable Refrigerant Flow System
Temperature Controls	Radiant Heating System	
Insulation	Vehicle Exhaust System	Energy Recovery Unit
Air Distribution Devices		

1.16 CLEANING

A. After the Architect/Engineer has completed examination, this Contractor shall remove all stickers, tags, etc., and shall thoroughly clean all equipment, fixtures, and materials installed under his section of the work.

B. Surplus material, rubbish and equipment resulting from the work shall be removed from the building and premises by the Contractor upon completion of the work in accordance with the General Conditions.

C. All equipment shall be thoroughly cleaned to "Factory New" condition prior to turning over to owner. Touch up or completely repaint equipment as required.

1.17 EXAMINATION OF SITE

A. Bidders shall visit the site before submitting proposals to satisfy themselves as to the nature and scope of the work and any difficulties attending to the execution.

B. The submission of a proposal will be construed as evidence that such an examination has been made. Later claims for labor, equipment, materials, etc., required for difficulties encountered which could have been foreseen had such an examination been made, will not be recognized.

1.18 PAINTING

A. All exposed interior and exterior piping, ductwork and equipment not prefinished by equipment manufacturer or new equipment or items installed under this division shall be thoroughly cleaned and readied for painting. Painting shall be provided under the general contract, Division 9. Consult painting contractor for special surface preparations that may be required. See other paragraphs contained herein for pipe color coding for "Piping Identification".

1.19 SINGULAR NUMBER

A. In all cases where a device or piece of equipment is referred to in the singular number (such as grille, lavatory, etc.), it is intended that such reference shall apply to as many such items as are required to complete the installation.

1.20 CONCEALMENT OF PIPING AND DUCTWORK

A. In general, furred ceilings and soffits are provided in parts of the building to conceal horizontal piping and ductwork. Vertical risers serving downfeed heating and air conditioning units shall be installed concealed, unless shown otherwise on the Drawings.

B. In the Mechanical Room, attic and areas without ceilings and similar unfinished areas, piping and ductwork shall be installed exposed.

C. All work installed exposed shall be installed neatly to ensure a pleasing final appearance, subject to Architect and Engineer's approval. Vertical piping shall be perfectly plumbed.

D. Particular care shall be exercised in the location of ceiling diffusers and outlets to avoid conflict with the work of other Divisions. Surface units in the Ceiling shall fit into the acoustical ceiling suspension system and shall, in general, be symmetrical with the light fixtures.

E. Refer to the Architectural Room Finish Schedules for the areas having suspended ceilings and install the work accordingly.

1.21 CONCRETE WORK AND ANCHOR BOLTS

A. The Contractor under this Division shall provide all concrete bases, curbs and pads for all floor and ground mounted equipment unless otherwise indicated.

B. The Contractor under this Division shall verify the sizes and locations of all supports, bases and pads prior to pouring of same to be certain that the installed units will be compatible.

C. The Contractor under this Division shall set anchor bolts for the equipment prior to pouring of concrete. Sizes and exact locations of bolts shall be determined by the manufacturer's recommendations for the equipment served.

D. Concrete work must be provided in strict accordance with Section 03310 Concrete Work As a minimum provide pads using 3500 psi concrete reinforced with WI.4 x WI.4 welded wire fabric. Chamfer top and edge corners with 3/4" preformed chamfer strips. Slope top to floor drain if drain is provided in pad.

1.22 WORK AND EQUIPMENT UNDER OTHER DIVISIONS

A. The Contractor under Division 26 will provide all power wiring and conduit and install and connect each item of electrical equipment furnished under this Division unless specified otherwise. He will also provide starting equipment for motors not specified to have starting equipment furnished under this Division.

1. Note: All low-voltage equipment (motorized dampers, etc.) shall be installed by the Temperature Controls Contractor.

B. The Contractor under other Divisions will provide the following:

1. Painting of all mechanical work throughout.

2. Electrical work as noted in Paragraph (A) above.

3. Furnish and install all access doors shown on the Architectural Drawings.

1.23 FLASHINGS

A. The Contractor under this Division shall furnish and install all required flashing necessary for ducts, piping, fans, equipment, etc., which rest on or pass through the exterior walls and roof to insure a watertight installation. All penetrations shall be in strict accordance with Architects instructions. Verify prior to construction. Coordinate all roof flashing materials and procedures with Roofing Contractor.

B. Flashings for plumbing vents and drains shall be sheet lead weighing no less than 3 pounds per square foot or as required by Architect/Engineer and roofing manufacturer.

C. Flashings for all equipment must be in strict accordance with Architect/Engineer and roofing manufacturer's requirements.

1.24 VALVE TAGS AND CHARTS

A. The Contractor under this Division shall attach a numbered brass tag to each valve installed under this Contract. Each number shall be prefixed with the letter "H" for heating valves and "P" for plumbing valves. Tags shall be attached to the valves by means of brass "S" hooks. Tags shall be Seton Name Plate Co., C.H. Hanson Co. or Identifications.

B. A chart headed "HEATING AND AIR CONDITIONING VALVE CHART" shall be prepared. Three original charts shall be prepared and approved by the engineer. One of each approved type chart shall be framed under glass and mounted on the wall in the main mechanical room where directed. Three photocopies of each chart shall be made and shall be submitted through normal shop drawing channels for approval and subsequent owner's files. Each chart shall be formatted as shown below: (All normally closed valves shall have a brass tag marked Normally Closed.)

HEATING AND AIR CONDITIONING VALVE CHART

PROJECT NAME

DATE

TAG NO.	VALVE LOCATION	VALVE TYPE/SIZE	VALVE FUNCTION

1.25 DRIVES, SHEAVES AND GUARDS

A. Each belt connected fan motor unit shall be provided with a V belt drive equal to Browning, Dayton, or Worthington. Belts shall be standard or high capacity type.

B. Sheaves shall be cast iron or steel, bored to fit properly on the shafts and secured with key of proper size. Sheaves having set screws alone will not be acceptable. Sheaves shall be variable pitched and shall be designed to give the indicated RPM at approximately the mid position of adjustment. Pitch diameters of sheaves shall be not less than 3.0 inches for "A" section belts; 5.4 inches for "B" section belts; 9.0 inches for "C" section belts; and 13.0 inches for "D" section belts.

C. Belts shall be selected for a minimum service factor of 1.4 (based on motor nameplate horsepower) and selected and matched in sets for equal tension.

D. All other drives shall be as described under the respective equipment paragraphs, as applicable. The equipment manufacturer shall furnish additional belts, pulleys and/or sheaves as required to meet field conditions. The Mechanical Contractor shall install all pulleys and belts as required and shall include labor and materials for the change-out of such devices in his base bid.

E. Belt Guards

1. Each belt drive shall be equipped with a guard, constructed of heavy sheet steel and designed to enclose all moving parts.

2. Guards shall be designed with adequate provision for motor adjustments. Means shall also be provided to permit oiling, use of speed counters and other maintenance and testing operations with the guard in place.

3. Where a guard is located on a fan inlet, guard shall have open mesh construction.

4. Guards shall be secured to the fans, foundations or floors by heavy angle supports and anchor bolts. Braces or supports secured to motors will not be permitted and braces or supports shall not "bridge" the vibration isolators.

F. Machinery Guards

1. Each rotating shaft flexible coupling shall be provided with a removable protective guard constructed of a U shaped heavy sheet steel plate with securing flange to floor or base. Length of guards shall be sufficient to overhang rotating couplings a minimum of 1" on each side.

1.26 MOTORS

A. Motors furnished under this Division shall have horsepower ratings sufficiently adequate to drive the equipment served at its rated capacity and shall have sufficient starting torque to overcome equipment inertia.

B. Motors shall be in accordance with the latest standards of the AIEE and NEMA, designed for specific voltage available and for continuous duty in 40 degrees C ambient temperature.

C. Motors shall be equal to General Electric, Westinghouse or Wagner. Unless specified otherwise, motors shall be open drip proof type.

D. Motors for all equipment shall have a nameplate rating at least 10% greater than the brake horsepower required for the equipment at rated capacity.

1.27 WIRING DIAGRAMS

A. The Contractor under this Division shall submit complete wiring diagrams to the Architect/Engineer for approval. Wiring diagrams shall show all electrical connections for air conditioning units, starters, switches, motors, controls, etc.

B. Standard wiring diagrams of manufacturer's equipment will not be acceptable for this project unless they are altered to agree with the project requirements. Wiring diagrams shall include all interlocks with other equipment, whether furnished by the manufacturer or not.

C. After review by the Architect/Engineer, a copy of the wiring diagrams shall be given to the Contractor under Division 26.

D. Unless specified otherwise, power supply wiring to power connections on equipment will be provided by the Contractor under Division 26. The Contractors under Division 23 shall be responsible for the control wiring and correct sequence of operation of all mechanical equipment after all wiring has been completed. Control wiring shall include wire, conduit and miscellaneous materials required for connecting control devices. The Control Contractor shall provide power wiring and connections to control equipment if this required power wiring is not shown on the Electrical Drawings and Specifications.

1.28 ACCESS PANELS

A. Access panels shown on the Architectural Drawings will be furnished and installed under Division 8. In addition, the Contractor under this Division shall furnish all other access panels needed for access to valves, vents, fire dampers, heat pump units, etc., in inaccessible locations installed under this Division of the work.

B. Access panels shall have a minimum size of 12" x 12" and shall be centered beneath equipment for accessibility and maintenance. Access panels must be of adequate size to service, observe, remove and maintain equipment.

C. Access panels shall be equal to the types specified under the Architectural Specifications. As a minimum the access panels shall be equivalent to Cesco Products style FB/FB SS, Besco, Inryco/Milcor, Phillips or equivalent, 14 gauge with vandal proof lock and frame as selected by Architect.

D. Ceiling Types

1. In areas with suspended acoustical tile ceilings (installed on exposed metal grid suspension system so that the tile may be readily removed), equipment, valves, etc., install above these ceilings will be considered to be accessible. Metal grid must be installed at heat pumps in such a manner as to be removable for removal of heat pump units.

2. All plastered ceilings or ceilings having concealed spline type of suspension system will be considered as not removable for accessibility to equipment; therefore, access panels will be required.

3. See Architectural Drawings and Specifications for the types of ceilings throughout the building.

1.29 EQUIPMENT DRAINS

A. Provide a drain line from each item of equipment requiring a drain (cooling coil drain pans, pumps, backflow preventers, heat pumps, etc.) to the nearest floor drain, roof drain, open receptacle, to outside of the building, or as shown.

B. Drains from units shall be trapped to provide easy water flow through the drain line. Install in strict accordance with manufacturer's recommendations.

1.30 EQUIPMENT IDENTIFICATION

A. Furnish and install on each item of equipment, such as pumps, switches, starters, pushbuttons, motors, fans, etc., a nameplate giving its name and function.

B. Nameplates shall be engraved bakelite (white letters on black background and shall be equal to Seton Nameplate Co., C.H. Hanson Co., or Identifications.)

C. All names and numbers for equipment and rooms shall be approved by the Architect before nameplates are prepared so that correct identification will be used.

1.31 OPERATIONAL INSTRUCTIONS

A. Furnish services of a fully competent operational instructor for a total of two (2) one day sessions, unless otherwise specified, as directed by Architect/Engineer to instruct operating personnel in operations and care of all equipment and systems (including control systems) and their various components.

1.32 CONNECTIONS TO EQUIPMENT SPECIFIED IN OTHER SECTIONS

A. Examine all Contract Documents and be thoroughly familiar with all items of equipment in other sections or by Owner, unless otherwise specified or indicated on Drawings. Rough-in for and make final connections to all equipment which requires any of the services specified in this Section and including furnishing and install all valves, P-traps, unions, vacuum breakers and all other specialties as required to make all work and equipment final and operating. It is the intent of the Contract Drawings to detail and indicate all such equipment; however, be responsible for notifying Architect/Engineer in writing of major discrepancies seven (7) days prior to Bid Date; otherwise, all such connections shall be made at no extra cost.

B. Unless specified otherwise, all conduit, wiring and connections for power to mechanical equipment will be provided by Electrical Contractor. Be responsible for correct sequences of operation of all mechanical equipment after all wiring has been completed.

1.33 PLATFORMS AND SUPPORTING STANDS

A. Provide each piece of equipment or apparatus suspended from ceiling or mounted above floor level with suitable structural support, pipe stand, platform or carrier in accordance with best recognized practice, as approved by Architect/Engineer as indicated on Drawings. Such supporting or mounting means shall be provided by each Contractor for all equipment furnished by him, unless otherwise specified. Exercise extreme care that structural members of building are not overloaded by such equipment. Submit shop drawings on prefabricated or field erected equipment supports not detailed on Drawings.

1.34 EQUIPMENT MOUNTING

A. All equipment with moving parts such as compressor, fans and air handling units, shall be mounted on vibration supports suitable for purpose of minimizing noise and vibration transmission unless otherwise specified and, in addition, shall be isolated from external connections such as piping and ducts, by means of flexible connections, vibration, absorbers or other approved means. Unitary equipment, such as small room heating units

and small exhaust fans, shall be rigidly braced and mounted to wall, floor or ceiling as required with toggle bolts or an approved expansion shield and bolt 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 and grilles, shall be gasketed and sealed to mounting surface. All roof mounted exhaust fans shall have 1/2 inch gasket between fan and curb.

1.35 EXPANSION COMPENSATORS

A. Erect piping to provide for expansion and contraction without harmful strain to building structural members, pipe and vibrating equipment. Provide expansion bends or devices other than those indicated, if, in Architect's/Engineer's opinion, such devices are required by field conditions. Unless indicated otherwise, expansion bends are preferred to use of expansion joints and shall not be substituted without Architect's/Engineers written permission.

1.36 VIBRATION AND SOUND CONTROL

A. Be responsible for unnecessary or undue vibration or sound transmitted throughout building due to negligence or improper installation of material and equipment and be responsible for correction of such conditions.

1.37 CLEANING OF PIPING, DUCTWORK AND EQUIPMENT

A. Install and maintain pipe and equipment which is clean and free of dust, dirt and scale. Where roughed in only, provide temporary air-tight covers at all pipe, duct and equipment openings. Provide protection from elements.

B. Upon completion of work, thoroughly clean and lubricate all equipment; clean and flush all piping as often as necessary to satisfy Architect/Engineer and Owner that system is clear of oil, dirt, scale or other foreign matter; clean all strainers after flushing operation and prior to balancing; clean ductwork to insure system is clear of dirt or other foreign matter prior to balancing. See Section 236100 for Chemical Cleaning Requirements.

C. Keep all nameplates on equipment clean and exposed for easy reading. Air filters, if in equipment used during construction, shall be replaced and if field conditions warrant, vacuum clean all ductwork which is unduly filled with dust and debris, prior to balancing. See Equipment Protection Requirements listed herein.

1.38 WRENCHES - TOOLS

A. Furnish special wrenches or tools necessary to dismantle or service equipment or appliances installed. Wrenches shall include necessary keys, handles and operators for valves, cocks and hydrants. Number of wrenches furnished in proportion to devices installed shall be on a 50% basis, but not less than two (2) of each type shall be provided. All wrenches shall be neatly mounted on a three-quarter inch plywood panel properly marked with laminated plastic plates. Panel shall be fastened to wall where designated by Architect/Engineer.

1.39 TESTS

A. See Section 23110 - Basic Materials and Methods.

1.40 PIPING IDENTIFICATION

A. Stencil all exposed piping, piping above lay-in ceiling, exposed piping located behind and within 4' 0" of all access panels.

B. Stencils shall be machine cut, applied after the final coat of paint using enamel paint, shall be installed on the piping at not over 20 foot intervals (or in each room whichever is greater) and shall have the following heights:

1. On pipe sizes 3" and over letters shall be 2" in height.

2. On pipe sizes smaller than 3", letters shall be 1" in height, colors for lettering shall be as scheduled herein.

C. In addition to the preceding stencils giving identification, provide arrows at each stencil giving the direction of flow of the material. Where flow can be in either direction, provide double-ended arrows. Each tee in piping shall be provided with markers on all three outlets. All zones shall be properly marked by zone numbers as noted on the Drawings.

D. All stencils and arrows shall be properly oriented so that descriptive name may be easily read from the floor. Install stencils and arrows on lower curvature of overhead piping and on side panel near bottom or on bottom of ductwork. (Glue-on or stick-on labels are not acceptable.)

E. Schedule Examples

Pipe	Abbr.	Pipe Color Code
Condensate Drain	CD	Gray with Black Letters
Refrigerant	REF	Black with Light Blue Letters

1.41 CATALOG DATA FOR THE OWNER (MAINTENANCE, OPERATION AND INSTRUCTION MANUALS)

A. The contractor under this Division shall prepare three (3) loose leaf, plastic bound 3 ring binders labeled on front cover, title page and binder edge "Job Title" (as indicated on the contract document) "Heating, Air Conditioning, Operations and Maintenance Data." Each manual shall be subdivided with section tabs and shall contain a title page and index. The title page shall contain the following information:

1. Job Title

2. Heating, Air Conditioning, Operation and Maintenance Manual

3. All Contractor Names, Address, Phone # and Contact Person

4. Architect and Engineer's Name, Address and Phone #

B. Each manual shall contain the following information:

1. Name and address of Consulting Engineer, Contractor, and index of equipment, including vendor (name and address).

2. Complete brochures, descriptive data, etc., on each piece of equipment, including all approved shop drawings. (The contractor must retain three (3) sets of approved shop drawings for this purpose).

3. Complete maintenance and operating instructions and parts list, prepared by the manufacturer, on each major piece of equipment. This includes blow-out views with labeled parts list.

4. All wiring diagrams for equipment and systems and control schematics. See paragraph on wiring diagrams listed herein before.

5. Contractor's parts and labor warranty statement, including effective start date, as well as all manufacturers' warranties.

C. Manuals shall be submitted to the Architect prior to final inspection of the buildings.

1.42 TEMPORARY HEAT AND WATER

A. See Division 1 for temporary heat and water requirements.

B. See Protection of HVAC Equipment listed herein.

1.43 ACCEPTANCE OF MATERIAL AND MANUFACTURERS

A. The Architect/Engineer reserves the right to determine if the contractor's proposed materials and equipment of any one manufacturer is acceptable in lieu of the specified material or equipment.

B. Where materials and equipment are listed on Drawings and specifications as acceptable or equivalent, this does not relieve the contractor and/or manufacturer from providing and proving to Architect/Engineer that their materials and equipment are equivalent to items the Architect/Engineer used as a guide specification.

C. The contractor and manufacturer must confirm to the Architect/Engineer that their equipment and materials will meet the space requirements of the project and that the equipment is easily accessible for maintenance and operation.

1.44 CLOSEOUT DOCUMENTS

A. Prior to this project to be considered as "Substantially Complete" the following documents must be presented and approved.

1. All required approval/inspection letters from the state and local government levels; to include but not limited to:

a. Kentucky Department of Housing, Buildings and Construction Approval Letter.

b. Kentucky Cabinet of Human Resources Approval Letter.

2. Owner's Operation and Maintenance Manuals.

3. Approved and mounted valve tag charts.

4. Complete air/hydronic balance report.

5. Hydronic system cleaning and treatment certification letter.

6. Record drawings approved and returned to the Architect/Engineer.

7. Evidence that all guarantees and warranties have been submitted on behalf of the owner.

8. Letter from each HVAC manufacturer stating that their equipment has been supplied in strict accordance with Contract Documents and that equipment has been checked out, started and is operating properly.

9. Letter from the Temperature Control Contractor stating that all controls have been installed in accordance with the Contract Documents and that all controls are operating properly.

B. See Mechanical Demolition Plans for equipment changes.

END OF SECTION 230510

SECTION 230593 - STARTING, TESTING AND BALANCING FOR HVAC

1.1 STARTING, TESTING AND BALANCING THE HEATING AND AIR CONDITIONING SYSTEMS

A. General

1. This section shall include the furnishing of all labor and materials to test and balance the mechanical systems.

2. Final testing and balancing of the air and hydronic systems shall be performed by an independent AABC or NEBB certified, professional balancing organization.

3. Prior to start of balancing operation, a meeting shall be conducted at the site with all subcontractors and the HVAC design engineer present, for the purpose of coordinating the completion of all necessary work prior to starting, testing and balancing the mechanical systems.

4. TAB Contractor shall be hired directly by the General Contractor as an independent third party contractor.

B. Start up by the Mechanical Contractor Prior to Balance Work

1. All equipment shall be cleaned of all foreign material.

2. All equipment shall be lubricated and placed in proper working order. Drives on rotating equipment shall be checked for proper rotation and alignment. V belt drives shall be checked and adjusted for proper tension as recommended by the manufacturer. All drives shall be set for the recommended speeds. All sheaves and bearing blocks shall be checked for any loose screws or nuts.

3. Where equipment requires a change of material, it shall be filled by the Contractor with material recommended by the equipment manufacturer.

4. All controls and safety devices shall be checked to determine that they are in place and properly installed.

C. Operational Tests by the Mechanical Contractor

1. Before starting air conditioning and ventilating fans, the plenums, etc., shall be completely cleaned of debris, foreign matter, construction dirt, etc. All dampers shall be checked and set in a full open position. The fans shall be started and run continuously for eight (8) hours at full volume. At the completion of the eight hour run, diffusers, coils, etc., shall be opened and cleaned of any collected debris.

2. Provide baffles, if necessary, for each diffuser requiring same, to prevent excessive drafts from diffuser due to its proximity to walls, columns, lights or other obstructions.

3. Heating and Air Conditioning System - Start the heating and air conditioning system at the completion of the project and adjust all equipment, controls, valves, etc., for proper operation during the first heating and cooling seasons.

4. The controls shall be calibrated and set and checked to make certain that all parts of the control system are functioning properly.

5. Upon completion of the start-up procedure and prior to acceptance by the Owner, the Contractor shall complete a performance test on each system to ensure that each component and the entire system is operating properly and as intended.

After all systems have been verified by Contractor as to their proper operation, he shall so advise the Architect.

6. The intent of the above requirements is to ensure that all equipment is operating properly within their designed capacity and is ready for final balancing.

7. The Contractor shall perform all required service and maintenance for equipment installed until the requirements of (5) and (6) above are fully complied with.

D. Balancing

1. Upon completion of the above tests and when the Contractor is satisfied that the air systems are ready for final balancing, the Engineer shall be notified.

2. Arrangements will be made for testing and balancing by an independent AABC or NEBB certified professional balancing organization. The Contractor shall provide one (1) man to accompany the balancer and make adjustments not normally provided by the balancing organization. The Balancing Contractor shall make a preliminary balance of the entire air and water system. This procedure is to determine if there are any problem areas in the systems. The Balancing Contractor shall submit this preliminary (hand written) report to the Engineer, the Mechanical Contractor, the Temperature Control Contractor and the Electrical Contractor for review. The Engineer shall then set up a meeting with all parties to solve any potential problems before final balance work and final temperature control check out and adjustments are started.

3. The final phase of the process will then be for the Balance Contractor, Control Contractor and Mechanical Contractor to work TOGETHER and do final balance work and final temperature control adjustments and check out at the same time. This process will save all parties involved many hours of duplicated work.

   a. The Engineer's representative shall be notified before start of balancing. The representative may be present during all or part of the final balancing.

4. Testing and balancing and controls final adjustments must be completed prior to final acceptance and beneficial occupancy by the Owner. At substantial completion of the project the Engineer and Owner will walk through the building with the Contractors to perform a random spot check of balance work, controls and equipment operation to ensure that all work is complete.

E. Final Acceptance and Project Completion

1. Final retainage release and acceptance by the Owner will be contingent upon the satisfactory completion by the Contractor of responsibilities as set forth in the above.

2. The performance demonstration referred to above shall be scheduled in advance of the Contract completion date. Required subsequent work determined by the Architect as a result of the performance demonstration shall not be a legitimate reason for Contract time extension.

1.2 SPECIFICATION FOR FINAL BALANCING WORK

A. The final balancing of the heating, ventilating and air conditioning systems in this building shall be performed by an AABC certified test and balance agency. Instruments used for testing and balancing of the systems shall have been calibrated within a period of

six (6) months prior to balancing at this project. All final test analysis reports shall include a letter of certification listing instrumentation used.

B. Three (3) copies of the complete test reports shall be submitted to the Architect/Engineer prior to final acceptance of the project.

C. The balancing agency shall perform the following tests and compile the following information:

1. Air Systems and Distribution Balance:

a. Design Conditions

CFM

Static Pressure

Motor H.P.

Minimum % of Fresh Air

Fan R.P.M.

Fan Motor Brake Horsepower

b. Installed Equipment

Manufacturer

Size

Arrange, Discharge Class

Motor H.P., Volt, Phase, Cycle and Full Load Amps Starter Heater Rating

Amps

c. Field Test

Fan Speed

Fan Motor Operating Amperes

Phase (1)____,(2)____,(3)____

Fan Motor Operating Brake Horsepower

Field Volts 1 2___,2 3___,1 3___

Static Pressure at Outlet. Total Pressure at Inlet

d. Velocity Test for Total Air

Discharge or Suction Duct Size

No. of Velocity Readings

Duct Average Velocity

Total CFM

e. Individual Outlets (grilles and/or diffusers)

Return and Exhaust

Each outlet shall be identified as to location and area

Outlet, mfg. and type

Outlet size

Outlet free area, core area, or neck area

Outlet factor

Required ft. per min. and test resultant velocity for each outlet

Required CFM and test results, each outlet

f. All tests shall be performed with calibrated Anemotherm Velometer, Aneomometer, or Manometer and Pitot Tube.

g. All outlets shall be set for air pattern.

h. All main supply air, return air, and exhaust air shall be adjusted and set for design CFM.

i. Provide entering and leaving air temperatures, (dB and wB) at each coil. Note the date, time and O.A. temperature dB and wB when readings are made.

D. Before commencing work, verify that systems are complete and operable. Ensure the following:

1. Equipment is operable and in a safe and normal condition.
2. Temperature control systems are installed complete and operable. At final balance work, the Temperature Control Contractor and Balance Contractor must work together as described above.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Correct fan rotation.
7. Fire and volume dampers are in place and open.
8. Coil fins have been cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage has been minimized.

E. Report any defects or deficiencies noted during balancing to Mechanical Contractor and the HVAC Engineer. Failure to do this will result in the report not being approved.

F. Promptly report abnormal conditions in mechanical systems or conditions which prevent system balance.

G. Beginning of work means acceptance of existing conditions. Notify the Design HVAC Engineer of completion of preliminary testing and balancing.

H. Provide instruments required for testing, adjusting and balancing operations. Make instruments available to Contracting Officer to facilitate spot checks during testing.

I. Provide additional balancing devices as required. Equipment Manufacturer to furnish additional sheaves, pulleys and belts as required for proper balancing, installed by the Mechanical Contractor.

J. Installation Tolerances At No Additional Cost To The Owner

1. Adjust air handling systems to plus or minus 10 percent for supply systems and plus or minus 10 percent for return and exhaust systems from figures indicated.
2. Adjust hydronic systems to plus or minus 10 percent of design conditions indicated.

K. Adjusting

1. Recorded data shall represent actually measured or observed condition.
2. Permanently mark settings of valves, dampers and other adjustment devices allowing setting to be restored. Set and lock memory stops.
3. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
4. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes and restoring thermostats to specified settings.
5. At final inspection, recheck random selections of data recorded in report. Recheck point or areas as selected and witnessed by the Owner/Engineer.

L. Air System Procedure

1. Adjust air handling and distribution systems to provide required or design supply, return and exhaust air quantities.
2. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
3. Measure air quantities at air inlets and outlets.
4. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
5. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
6. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
7. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
8. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
9. Adjust outside air automatic dampers, outside air, return air and exhaust dampers for design conditions.

10. Measure temperature conditions across outside air, return air and exhaust dampers to check leakage.

END OF SECTION 230593

SECTION 230719 – HVAC INSULATION

1.1 GENERAL

A. The General Conditions, Special Conditions and the applicable portions of Division 1 of the Specifications are a part of this Section.

B. The Contractor for this work shall be governed by any Alternate Bids requested insofar as they affect this work.

1.2 SCOPE

A. This work includes the furnishing of all insulation and labor, materials, equipment, etc., necessary for the proper and complete installation of insulation as shown on the Drawings and/or herein specified.

1.3 SHOP DRAWINGS

A. Shop Drawing shall be submitted on all insulation including name of manufacturer, materials of construction, manufacturer's details of installation, procedures, mastics, tape, glass cloth, molded fittings, etc. Shop drawings shall include all equipment, materials and accessories incidental to a proper and complete installation.

1.4 ACCEPTABLE INSULATING MATERIAL MANUFACTURERS

A. Insulations having the thermal and physical properties of the specific materials specified hereinafter, of any of the following manufacturers, or approved equal, are acceptable.

Armstrong Cork	Knauf
Johns Manville	Certain Teed/Saint Gobain
Owens Corning	Pittsburgh Corning
Rubatex	

B. The Architect reserves the right to determine if the proposed insulating materials of any one manufacturer are acceptable in lieu of the specific insulation selected for the following applications.

1.5 INSTALLATION

A. All workmanship shall reflect the best current practices in the trade. Installation shall be applied by an approved company regularly engaged in the application of insulation. A neat and workmanlike job will be required. No covering shall be applied to pipe lines or other mechanical equipment until they have been tested and accepted by the A/E.

B. Contours on exposed work shall be smooth and continuous. Cemented laps, flaps, bands and tapes shall be smoothly and securely pasted down; adhesives shall be liberally used in conformity with the requirements of the manufacturer.

C. Where more than one thickness of insulation is required, joints (both longitudinal and transverse) shall be staggered. All joints shall be tight and with insulation lengths tightly butted against each other. Where lengths are cut, cuts must be smooth and square and without breakage of end surfaces. Where insulation terminates at unions, equipment, etc., ends shall be neatly tapered and effectively vapor sealed where insulation is vapor sealed. All insulation shall be continuous through wall and ceiling openings and sleeves. Penciling and stove piping of pipe insulation will not be permitted.

D. On vapor sealed insulation, the vapor barrier shall be continuous over all insulation. Insulation (and vapor seal if required) shall be continuous through pipe sleeves and pipe hangers, unless otherwise specified.

E. It shall be understood that except where they deviate from specific requirements hereinafter written, all material shall be applied in strict accordance with the recommendations of the manufacturer, using their recommended mastics, clips, etc., and installation procedures.

F. Provide canvas jacket in addition to standard jacket on all exposed insulated piping (up to 6 ft. above finished floor) in Boiler Room and size for painting. Canvas shall be 8 ounce enameling canvas attached with polyvinyl acetate adhesive.

G. Insulation shall extend through hanger and support shield for all cold water piping to be hung in horizontal. Where piping is 2 1/2" and larger, a high compression cork or wood pipe support shall be installed under pipe.

H. For vertical piping, the bracket shall fit directly to pipe and insulation shall be applied around bracket and support rod.

I. Insulation on adjacent piping to flanges shall terminate a sufficient distance back from the flange faces to permit removal of bolts. Terminate by beveling tightly into piping. Flange insulation shall extend along and overlap pipe insulation by at least 2" and shall terminate with a snug fit into pipe insulation with beveled edge. Unions on cold and chilled water shall be insulated in the same manner as flanges. Taper and seal (ground) insulation in continuous runs of vapor sealed pipe at 20 foot intervals, similarly.

J. Any piping exposed in the air stream inside an air handling unit shall be covered with 20 mil PVC jacket pipe covering and sealed watertight in strict accordance with manufacturer's requirements.

K. Insulation shall meet the following fire hazard requirements as tested under procedure ASTM E 84, NFPA 255 and UL 723.

1. Flame spread, less than 25.
2. Smoke developed, less than 50.
3. Fuel Contribution, less than 50.

1.6 ITEMS TO BE INSULATED

A. All outside air ductwork and plenums, including both ERU supply/return ductwork.

B. All supply and return air ductwork, unless otherwise indicated.

C. Condensate drains.

D. Refrigerant piping

E. Kitchen hood exhaust ductwork (with fire-rated wrap per Specifications)

1.7 REQUIRED COVERING AND APPLICATION

A. Condensate Drain Piping; Refrigerant Piping.

1. Piping drops inside walls can be insulated with 1/2" Armstrong Armoflex polyethylene closed cell or equivalent insulation in lieu of 1" fiberglass noted above. Insulation shall be non split type and slipped over pipe before joints are soldered together. All fittings and connections shall be factory pre molded type and applied with factory recommended adhesive. Refrigerant piping less than 1"

diameter shall be insulated with ½" Armstrong Armoflex polyethylene closed cell or equivalent. Refrigerant piping greater than 1" diameter shall be insulated with 1" Armstrong Armoflex polyethylene closed cell or equivalent. All refrigerant piping insulation shall be installed in strict accordance with VRV equivalent manufacturer.

2. Refrigerant piping routed on the exterior or exposed to direct sunlight shall be coated with mastic coating for protection from the elements.

B. Ductwork - Supply, Return and Outside Air

1. Rectangular and round supply, return, and outside air ductwork shall be insulated with external insulation as noted below.

2. Externally insulated ductwork shall be insulated as follows:

a. Ductwork shall be externally insulated with 2" R-6.0 fiberglass ductwrap or Reflectix R-6.0 insulation having two outer layers of aluminum foil with polyethylene bonded for strength, and two inner layers of insulated bubbles; 5/16" thick; 1.25 oz./sq ft. Flame and smoke 20/30.

b. Insulation must be installed in strict accordance with insulation manufacturer's requirements. Provide pins, bands and adhesive as required. Special care must be taken on large ductwork to prevent sagging of insulation away from ductwork.

c. Ductwork must be sealed and tested prior to installing insulation.

Note: At contractor's option, foil-faced fiberglass insulation may be used. Insulation must be R-6.0 or greater.

C. Exhaust Ductwork

1. Exhaust ductwork shall not be insulated, except as noted.

D. Kitchen Exhaust (Grease Duct)

1. Kitchen hood exhaust (grease) duct shall be insulated with fireproof insulation which shall meet or exceed the following specifications:

a. Product Description: FireMaster® FastWrap XL (or approved equivalent) is a flexible blanket composed of high temperature fibers classified for applications to 2192°F (1200°C) and fully encapsulated in a durable glass fiber reinforced foil facing for easy handling and installation. FastWrap XL is UL Classified and ULC Listed in various systems for 1 and 2 hour fire resistive enclosure protection, reduced clearance for kitchen exhaust ducts, electrical circuit protection, and as a component in various UL firestop designs for fire resistance rated floors, ceilings, and walls. The core fibers in FastWrap XL are manufactured using Thermal Ceramics patented Superwool® fiber which is an alkaline-earth silicate wool with low biopersistence and therefore increased safety for installers. FastWrap XL is under UL's Follow-Up Service Program to ensure the consistent quality essential to this lifesafety application.

b. Product Features

i. Zero clearance to combustibles at any location

ii. Thin and Lightweight at 1-1/2" (38mm) thick, 6 pcf (96 kg/m3) density

iii. Contours easily to complex duct designs

iv. Optimized installation with inside layer butt joints on grease duct enclosures per ASTM E 2336

v. Fully foil encapsulated for fast and clean installation

vi. Completely inorganic and non-combustible

vii. Contains 2192°F (1200°C) rated fibers for added safety margin

viii. Wide variety of through penetration firestop systems

ix. Resistant to mold growth

x. Good sound absorption

c. Applications

i. 1 and 2 hour enclosure and firestop system for kitchen exhaust ducts

ii. Zero clearance from enclosure to combustibles for kitchen exhaust ducts

iii. 1 and 2 hour enclosure and firestop system for hazardous exhaust ducts, pressurization ducts, clothes dryer exhaust ducts, trash and linen chutes, and other fire rated HVAC ducts

iv. 1 hour circuit integrity protection for cable trays and steel conduits

v. Engineered solutions and tested systems for fire protection of structural steel beams and columns, and storage vessels per ASTM E119, ISO 834, and UL1709

d. Storage: Insulation must be stored in a dry warehouse environment on pallets. Pallets should not be stacked.

e. Installation: Insulation shall be installed by a qualified contractor in accordance with manufacturer's instructions and design listings. See figures 1 to 5 for complete details.

f. Materials and Equipment

i. FastWrap XL blanket

ii. Aluminum foil tape

iii. Glass filament reinforced tape (optional)

iv. Carbon steel or stainless steel banding material, minimum

v. 1/2" (13mm) wide, minimum 0.015" (0.4mm) thick, with steel banding clips

vi. Hand banding tensioner and crimping tool

vii. Minimum 12 gage (3mm) steel insulation pins; steel speed clips, minimum 1-1/2" (38mm) square or 1-1/2" (38mm) diameter, or equivalent sized cup-head pins; Capacitor discharge stud gun

viii. FireMaster F2-HT-XL3 Prefabricated Door or Field Fabricated

ix. Door Hardware

x. An approved firestop sealant

E. NOTE: All areas in the piping system which requires general maintenance shall be insulated such that maintenance functions can be made without damaging the insulation.

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Owner's Project Requirements and Systems Basis of Design documentation are included by reference.

C. Commissioning Plan and Appendices.

1.02 SUMMARY

A. Section includes commissioning process requirements for HVAC Systems, assemblies, and equipment.

B. Related Sections:

1. Section 017900 – Demonstration and Training
2. Section 019113 - General Commissioning Requirements
3. Section 019113.13 – Functional Testing
4. Division 23 sections for HVAC equipment and assemblies

1.03 SYSTEMS COMMISSIONED

A. HVAC Equipment List:

1. VRV Outdoor Units
2. VRV Indoor Units
3. Energy Recovery Ventilator
4. Rooftop Heat Pump Unit
5. Vehicle Exhaust Fan
6. Mini Split Heat Pumps
7. Inline Heater and Fan (Decon Room)
8. Electric Wall Mounted Units
9. Gas-Fired Unitary Heaters
10. Kitchen Hood
11. Louvers w/ Motorized Dampers
12. Hydronic Radiant Heaters (Apparatus Bay)
13. Wall Cavity Exhaust Fans
14. Circulation Fans

1.04 CONTRACTOR'S RESPONSIBILITIES

A. Attend Construction Phase Commissioning Conference.

B. Satisfy applicable project Owner's Project Requirements.

C. Review the Commissioning Plan prepared by Commissioning Authority.

D. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.

E. Cooperate with the Commissioning Authority for resolution of issues recorded in the Issues Tracking Log. Resolution will occur within one week of finding and notification.

F. Attend Commissioning Team Meetings held on a bi-weekly basis.

G. Integrate and coordinate commissioning process activities with Construction Schedule.

H. Review, accept, and support execution of Construction Checklists provided by the Commissioning Authority.

I. Support completion of Construction Checklists as Work is completed.

J. Review and accept Functional Test Procedures provided by the Commissioning Authority.

K. Support completion of Functional Test Procedures, including seasonal and any deferred test procedures.

L. Provide Owner training as directed in equipment specification sections and Section 017900.

M. Provide O&M Manuals as required by the A/E.

N. Provide project specific close-out documents as required for the systems manual per LEED EAc3: Enhanced Commissioning.

O. Provide access to electrical, water, scaffolding, man-lifts, of other mechanical conveyances used by the contractors to perform their work during functional and performance testing under the direction of the CA. If mechanical conveyances are unavailable during the commissioning process, the Construction Manager will provide the necessary equipment for access required.

1.05 COMMISSIONING AUTHORITY'S RESPONSIBILITIES

A. See specification section 019113, 1.07 'Commissioning Authority's Responsibilities'

1.06 CONTROL CONTRACTOR'S RESPONSIBILITIES

A. Due to the impact the Facility Management System has on the success of functional testing, the following supplemental requirements shall apply.

B. Project specific responsibilities of Controls Contractor:

1. Provide a written plan to the Commissioning Authority and Architect / Engineer describing process for completing checkout and start-up of Controls System.
2. Refer to the specifications for controls for the scope of controls function verification the Commissioning Authority will complete after controls checkout.
3. Provide resources to facilitate Functional Testing of HVAC Systems, assemblies, equipment, and components including but not limited to technicians, any necessary unique instruments for setting terminal units or controllers, and passwords for control system interfaces.
4. Provide resources to facilitate testing, adjusting, and balancing of Work. Refer to Section 1.07 "TAB Commissioning Specialties" and Specification Section 019113.13 – Functional Testing.
5. Functional testing of controls shall be completed and approved prior to start of TAB work. Refer to Section 1.07 "TAB Commissioning Specialties" and Specification Section 019113.13 – Functional Testing.

1.07 TAB COMMISSIONING SPECIALTIES

A. To facilitate the commissioning process the following requirements shall apply:

1. Prior to TAB work, the Controls Contractor shall meet with TAB Contractor to coordinate capabilities and requirements of control system for use in TAB work. Verify with Commissioning Authority that controls Functional Testing has been completed and approved.
2. Controls Contractor shall provide access to the TAB Contractor any unique instruments for setting terminal units, controllers, or other devices and instruct in their use.
3. Controls Contractor shall provide a technician qualified to operate building controls to assist in TAB; coordinate scheduling with TAB Contractor.

1.08 COMMISSIONING SUBMITTALS

A. Equipment submittals for commissioned systems, assemblies, equipment, and components will be reviewed by the Commissioning Authority as part of the normal submission procedure.

B. All testing plans and schedules to be reviewed and approved by Commissioning Authority as indicated in this Section and the Commissioning Plan.

1. Duct Pressure Testing
2. Testing, Adjusting, and Balancing
3. Building Automation System Graphical Interface
4. Building Automation System Point-to-point Check

1.09 COMMISSIONING DOCUMENTATION

A. Contractor shall provide the following information to the Commissioning Authority during the commissioning process for inclusion in the Commissioning Plan:

1. Process and schedule for supporting completion of Construction Checklists for HVAC Systems, assemblies, equipment, and components to be verified and tested.
2. Support completion of Construction Checklists for review and approval by Commissioning Authority and Architect / Engineer.

B. In addition to the requirements detailed in applicable Division 23 sections, the Contractor shall provide the following information, in electronic form, to the Architect / Engineer for inclusion in the Commissioning Report:

1. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
2. Test and inspection reports and certificates.
3. Completed Functional Test procedures.
4. Response to corrective action documents.
5. A record of Owner training sessions.

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.01 CONSTRUCTION CHECKLISTS PREPARATION

A. Refer to Section 019113 - General Commissioning Requirements for complete procedures and requirements.

3.02 CONSTRUCTION CHECKLISTS EXECUTION

A. Refer to Section 019113 - General Commissioning Requirements for complete procedures and requirements.

3.03 FUNCTIONAL TEST PREPARATION

A. Refer to Section 019113.13 – Functional Testing for complete procedures and requirements.

3.04 FUNCTIONAL TEST EXECUTION

A. Refer to Section 019113.13 – Functional Testing for description of tasks to complete for this project.

3.05 GENERAL FUNCTIONAL TESTING REQUIREMENTS

A. Refer to Section 019113.13 – Functional Testing for complete procedures and requirements.

3.06 POST ACCEPTANCE PERIOD

A. Refer to Section 019113.13 – Functional Testing for complete seasonal or deferred testing procedures and requirements.

3.07 OWNER TRAINING

A. Refer to Section 017900 – Demonstration and Training for Owner Training requirements for this project.

END OF SECTION 230800

SECTION 230900 – DIRECT DIGITAL CONTROLS

PART 1 - GENERAL

1.1 MANUFACTURERS

A. The following manufacturers shall be acceptable:

1. Daikin (Basis of Design)
2. LG
3. Trane
4. Samsung

B. All references to Daikin-specific products referenced within this document shall be interchangeable with the manufacturers' products listed above.

1.2 PHYSICAL CHARACTERISTICS

A. General:

1. The advanced multi-zone controller shall be made from plastic materials with a neutral color. Each control shall have a LCD (Liquid Crystal Display) that shows On/Off, setpoint, room temperature, mode of operation (Cool/Heat/Dry/Fan/Auto), louver position, and fan speed.

1.3 ELECTRICAL CHARACTERISTICS

A. General:

1. The advanced multi-zone controller will require 24 VAC to power the controller. The advanced multi-zone controller shall supply 16 VDC to the communication bus on the F1F2 (out-out) terminal of the outdoor unit. The voltage may rise or fall in relation to the transmission packets that are sent and received.

B. Wiring:

1. The advanced multi-zone controller communication wiring shall be terminated in a daisy chain design at the outdoor unit, which is then daisy chained to branch selector, then daisy chained to each indoor unit in the system and terminating at the farthest indoor unit. The termination of the wiring shall be non-polar. The remote control wiring shall run from the indoor unit control terminal block to the remote controller connected with that indoor unit.

C. Wiring size:

1. Wiring shall be non-shielded, 2-conductor sheathed vinyl cord or cable, and 18 AWG stranded copper wire.

1.4 VRV CONTROLS NETWORK

A. The VRV Controls Network is made up of local remote controllers, multi-zone controllers, advanced multi-zone controllers, and open protocol network devices that transmit information via the communication bus. The VRV Controls Network shall also have the ability to be accessed via a networked PC. The VRV Controls Network must support operation monitoring, scheduling, error e-mail distribution, general user software, maintenance support, and integration with Building Management Systems (BMS) using open protocol via BACnet® interface.

PART 2 - PRODUCTS

2.1 ADVANCED MULTI-ZONE CONTROLLERS

A. The Daikin AC VRV advanced multi-zone controllers are compatible with all VRV, SkyAir, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. The advanced multi-zone controller wiring consist of a non-polar two-wire connection to the outdoor unit. The advanced multi-zone controllers may be wall-mounted and can be adjusted to maintain the optimal operation of up to 64 connected indoor unit groups and 128 indoor units. Set temperatures can be adjusted in increments of 1°F. In the cases where a system or unit error may occur, the VRV controllers will display a two-digit error code and the unit address.

2.2 DCM601A71: INTELLIGENT TOUCH MANAGER (ITM) V2.XX.XX

A. The intelligent Touch Manager (version 2.04) shall provide control for all VRV, SkyAir, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. It shall be capable of controlling a maximum or 64 indoor unit groups and 128 indoor units connected to a maximum of 10 outdoor units. The intelligent Touch Manager shall support operations superseding that of the local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.

B. The controller wiring shall consist of a non-polar two-wire connection to the indoor unit at terminals F1F2 (out-out) of the outdoor unit. The intelligent Touch Manager is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s).

C. The intelligent Touch Manager can be used in conjunction with both the localized controllers and BACnet interface to control the same indoor unit groups. The remote controller shall require daisy chain wiring for grouping multiple indoor units (up to 16) together. Manual addressing is required of each remote controller group associated with the intelligent Touch Manager. DIII-NET address can be set for one (1) indoor unit or each indoor unit in the remote controller group. No more than 2 remote controllers can be placed in the same group.

D. The intelligent Touch Manager shall be equipped with two RJ-45 Ethernet ports for 100 Mbps network communication to support interconnection with a network PC via the Internet, Local Area Network (LAN), or connection with a non-networked PC after completed installation.

E. Web access functions shall be available so that facility staff can securely log into each Intelligent Touch Manager via the PC's web browser to support monitoring, scheduling, error recognition, and general user functions. Error emails are also sent to designated email addresses. An additional optional software function Power Proportional Distribution (PPD) tenant billing shall also be available. The optional software shall require advanced purchase and can only be activated upon receipt of a license activation key from Daikin AC.

1. Mounting:

   a. The intelligent Touch Manager shall be mounted on the wall or into the mounting fixtures included with the intelligent Touch Manager.

2. Display Features:

   a. The intelligent Touch Manager shall be approximately 11.42" x 9.57" x 1.97' in size with a backlit 10.4" LCD display.

b. Display information shall be selectable from English, French, Italian, Korean, Dutch, Portuguese, Chinese, Japanese, German, or Spanish.

c. Featured backlit LCD with auto off after 30 minutes (default) is adjustable between 1 to 60 minutes, or the choice of 3 different screen savers.

d. Area and Group configuration

1) Area contains one (1) or more Area(s) or Group(s)

2) A Group may be an indoor unit, Di, Dio point that has a DIII-Net address

3) A Group may be an external management point such as a Di, Do, Bi, Bo, Bv, Ai, Ao, Av, Mi, Mo, Mv that does not have a DIII-Net address

e. An Area is a tiered group where management points (indoor unit, digital input/output, and analog input/output groups) can be monitored and controlled by global settings. Up to 650 Areas can be created. Area hierarchy can have up to 10 tiered levels (ex. top level: 1st floor West, 2nd level: offices, hallways, 3rd level: Office 101, 102, and 103, etc.). Area configuration shall classify levels of monitoring and control for each management point

1) Areas and Groups may be assigned names (ex. Office 101, Lobby, North Hallway, etc.)

f. The Controller shall display On/Off, Operation Mode, Setpoint, Space Temperature, Louver Position, Fan Speed for each Area or Group.

g. The Controller shall display Date (mm/dd/yyyy, yyyy/mm/dd, or dd/mm/yyyy format selectable) and day of the week along with the time of day (12hr or 24hr display selectable).

h. The Controller shall adjust for daylight savings time (DST) automatically.

i. Display information shall be updated every 3 seconds to show the latest status of the indoor unit groups.

j. System status icons shall display On/Off (color coded), Malfunction/Error (color coded), Forced Stop, Setback, Filter, Maintenance, and Screen Lock.

k. The controller shall display the temperature setpoint in one degree increments with a range of 60oF – 90oF, 1oF basis (16oC – 32oC, 0.1oC basis).

1) Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius

l. Display shall reflect room temperature in one tenth degree increments with a range of-58oF – 248oF, 0.1oF basis (-50oC – 120oC, 0.1oC basis) with 0.1oC accuracy.

1) Display of room temperature information shall be configurable for Fahrenheit or Celsius

m. The Menu List shall be used to configure options and display infor-

mation for each Area or Group.

n. Error status shall be displayed in the event of system abnormality/error with one of three color coded icons placed over the indoor unit icon or lower task bar.

1) System errors are generated when the intelligent Touch Manager system with other VRV controls systems are combined incorrectly or power proportional distribution calculation errors occur. The intelligent Touch Manager shall display the error with a red triangle placed on the lower task bar.

2) Unit errors occurring within the VRV system shall be displayed with a yellow triangle placed over the indoor unit icon

3) Limit errors are based upon preconfigured analog input upper and lower limit settings and are generated when the limits have been met. When limit error is generated a yellow triangle will be placed over the unit icon.

4) Communication errors between the intelligent Touch Manager and the indoor units shall be displayed with a blue triangle placed over the indoor unit icon

5) Error history shall be available for viewing for up to 500,000 errors/abnormality events with operation events.

o. Layout View

1) Capable of displaying site floor plan or graphical user interface (GUI) as the background for visual navigation. Indoor unit, DIII-Net Di and Dio, and External Di, Do, Ai, Ao, Av, Mi, Mo, Mv icons with operational status can be placed on the floor layout or GUI

a) Up to 4 status points can be assigned to the indoor unit icon (room name, room temperature, setpoint, and mode)

b) Digital input and output icons will display On/Off status

c) Analog icons will display Ai, Ao and Av.

d) Multistate icons will display Mi, Mo and Mv.

2) Up to 60 floor layout sections can be created

3. Basic Operation:

a. Capable of controlling by Area(s) or Group(s)

b. Controller shall control the following group operations:

1) On/Off

2) Operation Mode (Cool, Heat, Fan, Dry, and Auto)

3) Independent Cool and Heat dual Setpoints or single Setpoint for current mode in the occupied period

4) Controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating based upon the Area or

Group configurations

5) Independent Setup (Cooling) and Setback (Heating) setpoints in the unoccupied mode adjustable to 50 - 950F

a) Setup and Setback setpoints can only be set outside of the occupied setpoint range

b) The Setup and Setback setpoints will automatically maintain a 2oF fixed differential from the highest possible occupied setpoints

c) The recovery differential shall be 40F (default) and adjustable between 2 – 100F

d) Settings shall be applied based upon the Area or Group configurations

6) Fan Speed

a) Up to 3 speeds (dependent upon indoor unit type)

7) Airflow direction (dependent upon indoor unit type)

a) 5 fixed positions or oscillating

8) Remote controller permit/prohibit of On/Off, Mode, and Setpoint

9) Lock out setting for Intelligent Touch Manager display

10) Indoor unit Group/Area assignment

c. Capable of providing battery backup power for the clock at least 1 year when no AC power is applied.

1) The battery can last at least 13 years when AC power is applied

d. Settings stored in non-volatile memory

4. Programmability:

a. Controller shall support integration of rooftop Energy Recovery Unit as scheduled. Controller shall monitor all unit alarms and report locally as well as support e-mail communication of ERU alarms. *All read-only points provided by the ERU controller shall be available as read-only points at the VRF controller. All writeable points shall be writeable at the VRF controller.*

b. Controller shall support weekly schedule settings.

1) 7 day weekly pattern (7)

2) Weekday + Weekend (5 + 2)

3) Weekday + Saturday + Sunday (5 + 1 + 1)

4) Everyday (1)

5) The schedule shall have the capabilities of being enabled or disabled

6) 100 independent schedules configurable with up to 20 events settable for each days schedule

a) Each scheduled event shall specify time and target Area or Group

b) Each scheduled event shall include On/Off, Optimum Start, Operation Mode, Occupied Setpoints, Setback Setpoints, Remote Controller On/Off Prohibit, Remote Controller Mode Prohibit, Remote Controller Setpoint Prohibit, Timer Extension Setting, Fan Speed, and Set-point Range Limit

- Setpoint when unit is On (occupied)
- Configurable Setup (Cooling) and Setback (Heating) setpoints when unit is Off (unoccupied)

c) Time setting in 1-minute increments

d) Timer Extension shall be used for a timed override (settable from 30 – 180 minutes) to allow indoor unit operation during the unoccupied period

7) A maximum of 40 exception days can be schedule on the yearly schedule (repeats yearly)

a) Exception days shall be used to override specified days on the weekly schedule based upon irregular occupied/unoccupied conditions

b) Exception days can be configured on a set date (Jan 1) or floating date (1st Monday in September)

c. Controller shall support auto-changeover.

1) Auto-change shall provide Fixed (default), Individual, Averaging, and Vote changeover methods for both Heat Pump and Heat Recovery systems based upon the changeover group configuration. This will allow for the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat in accordance with the room temperature and setpoint. The following changeover scheme shall be applicable to the Fixed, Individual, and Averaging methods.

a) Changeover to cooling mode shall occur at cooling setpoint + 1oF (0.5oC) as the primary changeover deadband and takes the guard timer into consideration

- Configurable from 1 – 4oF (0.5 – 2oC)

b) Changeover to cooling mode shall occur at the primary changeover deadband to cooling + 1oF (0.5oC) as the secondary changeover deadband.

- Configurable from 1 – 4oF (0.5 – 2oC)

c) Changeover to heating mode shall occur at heating setpoint - 1oF (0.5oC) as the primary changeover deadband and takes the guard timer into consideration

- Configurable from 1 – 4oF (0.5 – 2oC)

d) Changeover to heating mode shall occur at the primary changeover deadband to heating - 1oF (0.5oC) as the secondary changeover deadband.

- Configurable from 1 – 4oF (0.5 – 2oC)

e) A weighted demand shall be configurable for the Averaging and Vote methods.

2) Fixed Method

a) Changeover evaluated by room temperature and setpoint of the representative indoor unit (first registered indoor unit in changeover group) in the changeover group even when it is not operating (must be in Cool, Heat, or Auto mode)

b) Changeover affects all indoor unit groups in the changeover group.

3) Individual method (recommended for Heat Recovery Systems)

a) Changeover evaluated by room temperature and setpoints of the individual indoor unit group in the changeover group

b) Changeover affects individual indoor unit group in the changeover group

4) Average method

a) Changeover evaluated by the average of all indoor unit group's room temperatures and setpoints operating in Cool, Heat, or Auto mode in the changeover group list

b) If none of the indoor units in the group meet the above requirements the Fixed method of changeover will be applied

c) A weighted demand (0 – 3) can be configured for each indoor unit in the changeover group.

d) Changeover affects all indoor unit groups in the changeover group.

5) Vote Method

a) In each indoor unit, the cooling demand is calculated based upon the difference between the room temperature and cooling setpoint. If the room temperature falls below the primary cool changeover point (cool setpoint plus the primary changeover deadband) the cooling demand is considered as 0 (zero). Then the total cooling demand is calculated as the sum of each indoor unit's cooling demand

b) The opposite is true for the total heating demand

c) A weight (0-3) can be added to each indoor unit's demand in the changeover group. The default setting is 1

d) The weight 0 (zero) means the indoor unit's demand is not added in the total demand, so the indoor unit's demand is considered to be 0 (zero)

e) The weight 2 or 3 means the indoor unit's demand is added 2 or 3 times in the total demand, respectively

f) Changeover to cooling mode shall occur when the total cooling demand is greater than the total heating demand.

g) The opposite is true for changeover to heating

h) Vote supports a Heating Override option, which prioritizes switching to the heating mode if at least one room temperature falls below the secondary heat changeover point (heat setpoint minus the secondary changeover deadband) even if the total cooling demand is greater than the total heating demand.

i) Changeover affects all indoor unit groups in the changeover group.

6) Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained to the same outdoor unit in the Heat Pump system or branch selector box in the Heat Recovery system.

7) Guard timer

a) Upon changeover, guard timer will prevent another changeover during the guard timer activation period (15, 30, 60 (default) min).

b) Guard timer is ignored by a change of setpoint manually from either intelligent Touch Manger or Remote Controller, by schedule, or the room temperature meets or exceeds the secondary changeover deadband of the mode opposite of the current mode setting

d. Controller shall support Interlock

1) Interlock feature for use with 3rd party equipment (DOAS, dampers, occupancy sensing, etc...) to automatically control Groups or Areas corresponding to the change of the operation states or the On/Off states of any Group.

2) WAGO I/O unit – Di, Do, Ai, Ao

a) On/Off based monitoring and control of equipment

b) Manual or scheduled operation of equipment

c) Operation based upon interlock with management points (group(s))

d) Monitor equipment error/alarm status

3) Digital Input/Output (DEC102A51-US2) unit or Digital Input (DEC101A51-US2) unit

a) On/Off based monitoring and control of equipment

b) Manual or scheduled operation of equipment

c) Operation based upon interlock with management points (group(s))

d) Monitor equipment error/alarm status

e. Controller shall support force shutdown of associated indoor unit groups.

5. Web/Email Function

a. Each intelligent Touch Manager shall be capable of monitoring, operating, and scheduling a maximum of 64 indoor unit groups (up to 512 indoor unit groups with the addition of the iTM Plus Adapter) from a networked PC's web browser. It shall also be capable of creating general user access and sending detailed error emails to a customized distribution list (up to 10 email addresses).

b. All PCs shall be field supplied

6. Required Software

a. Licensed per option, per intelligent Touch Manager shall be required.

b. DCM009A51: BACnet Client Option

1) The iTM BACnet Client Option shall be capable of making the intelligent Touch Manager work as a BACnet client using the BACnet/IP protocol. A BACnet client machine is able to send service requests to a BACnet server machine that then performs the services and reports the results to the client. By registering equipment and sensors connected to a BACnet server as management points, equipment and sensors can be monitored and controlled by the intelligent Touch Manager. The BACnet Client option must be enabled/ activated in each intelligent Touch Manager to be used.

2) System Capacity

a) A maximum of 50 BACnet servers can be monitored and/or controlled by one intelligent Touch Manager.

b) A maximum of 1536 objects can be monitored and/or controlled by one intelligent Touch Manager.

c) A maximum of 512 management points, including BACnet management points, external management points, internal Ai management points, AHU management points, and Chiller management points, can be registered in one intelligent Touch Manager.

3) Objects that can be used in BACnet management points are:

a) Analog Input (Object Type Number 0)

b) Analog Output (Object Type Number 1)

c) Analog Value (Object Type Number 2)

d) Binary Input (Object Type Number 3)

e) Binary Output (Object Type Number 4)

f) Binary Value (Object Type Number 5)

g) Multi-Sate Input (Object Type Number 13)

h) Multi-Sate Output (Object Type Number 14)

i) Multi-Sate Value (Object Type Number 19)

END OF SECTION 230900

SECTION 231110 - BASIC MATERIALS AND METHODS FOR HVAC

1.1 WELDING AND BRAZING

A. All welds shall be of sound metal thoroughly fused to the base metal at all points, free from cracks; and reasonably free from oxidation, blow holes, and non metallic inclusions. No fins or weld metal shall project within the pipe; and should they occur shall be removed. All pipe beveling shall be done by machine. The surface of all parts to be welded shall be thoroughly cleaned free from paint, oil, rust or scale, at the time of welding except that a light coat of oil may be used to preserve the beveled surfaces from rust.

B. All pipe and fittings shall be carefully aligned with adjacent parts and this alignment must be preserved in a rigid manner during the process of welding.

C. It is required that all welding of piping covered by this Specification, regardless of conditions of service, be installed as follows:

1. Pipe welding shall comply with the provisions of the latest revisions of the applicable code whether ASME "Boiler construction Code," ANSI "Code for Pressure Piping," AWS and/or Kentucky KRS 236 "Boiler Safety Law". The Contractor shall make arrangements for inspection visits by the state boiler inspector as required by KRS 236 and must comply with all Boiler Inspector requirements.

2. The Contractor's welding procedure shall clearly set forth P numbers of parent metal to be welded, rod or filler metal to be used and positions required. Welder's qualifications shall specify results of test, or retest, positions qualified and type of welding in which qualified.

3. Before any pipe welding is performed, the Contractor shall submit to the Architect/Engineer a copy of his welding procedure Specifications together with proof of its qualification as outlined and required by the most recent issue of the code having jurisdiction.

4. Before any operator shall perform any pipe welding, the Contractor shall also submit to the Architect/Engineer, the operator's qualification record in conformance with provisions of the Code having jurisdiction, showing that the operator was tested under the approved procedure specification submitted by the Contractor.

   a. Welding work shall not be performed by welders who are not approved by the Architect/Engineer, and any such work performed shall be summarily removed and replace without further recourse by the Contractor.

   b. Standard Procedure Specifications and operators qualified by the National Certified Pipe Welding Bureau shall be considered as conforming to the requirements of the Specifications.

5. Each manufacturer or contractor shall be responsible for the quality of welding done by his organization and shall repair any work not in accordance with these Specifications.

6. Brazing, when specified or indicated on the Contract Drawings, shall be done in accordance with Part UB of Section VIII of the ASME Code.

D. All expenses in connection with the preceding shall be borne by the Contractor under this Division.

1.2 TESTS

A. The Architect/Engineer shall be notified by the Contractor under this Division forty eight (48) hours in advance of any tests so that the Architect/Engineer or his representative may be present when the tests are run. Leaks or imperfections found shall be corrected and a new test run to the satisfaction of the Architect/Engineer. Upon successful completion of the test, pipe covering may be applied and piping may be concealed. A successful test, even if witnessed, however, does not relieve the Contractor under this Division of the responsibility for any failure during the guarantee period.

B. After pipe fabrication has been completed, all water piping shall be subjected to a hydrostatic test of 100 psi and proven tight and free of leaks for a 24 hour period. Tests shall be applied to the piping before being attached to any equipment which would be damaged by the test pressure. Damage to equipment caused by testing shall be repaired or replaced without additional cost to the Owner.

C. No insulation, paint, backfill or other prohibitive covering shall be applied to piping prior to the above tests.

D. Provide all temporary equipment, materials, valves, gauges, etc., required for the preceding tests.

E. The expense of all tests shall be borne by the Contractor under this Division.

F. All low pressure ductwork shall be air tested in strict accordance with SMACNA Standards.

1.3 EXPANSION OF PIPING

A. Risers and horizontal runs shall be equipped with the necessary expansion loops or arms to accommodate maximum expansion anticipated. Runouts to risers shall have offset swings between main and riser.

B. Provide expansion loops at the locations and of the dimensions shown on the Drawings and as required per field conditions.

1.4 GRADING OF PIPING

A. Heating and Air Conditioning Water Piping

1. In general, water piping shall be installed with top of pipes "dead level" unless shown otherwise on the Drawings. Where pitch is indicated, it shall be a minimum of 1/4" in 10 feet. Long supply and return runouts from mains shall pitch up in the direction of flow and terminate with air vents described hereinafter. System must be completely drainable. Install hose bibbs at low points as required.

B. Drain Lines

1. Drain lines from equipment shall pitch down 1/8" per foot in the direction of flow.

1.5 PIPE ANCHORS

A. Provide anchors at the locations shown on the Drawings and as required per field conditions.

B. Anchors shall consist of heavy steel collars welded to pipe and secured to the building structure to prevent movement of piping.

C. Anchors shall be approved by the Architect/Engineer before installation is started.

1.6 PIPE SUPPORTS

A. Piping shall be run parallel to the building walls and shall be grouped in neat rows. Piping shall be supported to maintain required grading and to prevent vibration and shall be arranged to allow for expansion and contraction. Hanger rods longer than three feet (3') shall be restrained to prevent swinging of the pipes. Hangers shall be sized in accordance with the manufacturer's recommendations.

B. Where piping is to be supported from the concrete construction, provide inserts installed directly in the slabs. Concrete inserts shall be malleable iron; Grinnell Figure 282.

C. Where piping is to be supported from steel joist construction, provide supplementary steel angles or steel pipe welded between joists, or the use of approved joist and beam clamps. Steel members spanning between joists shall be attached to the top chord of joists not bottom chords. Where piping is to be supported from wood joist construction, hangers shall be supported by bolts thru center of joist.

D. In areas where concrete floors over steel decking is used, drill holes through deck into concrete and use expansion shields. Proof load of expansion shields in pull out shall be four times applied load. Steel decking alone shall not be used to support ductwork, piping, equipment, etc.

E. Piping, except as hereinafter specified, shall be supported by hangers, supports and/or stands, of the following Grinnell Figure Numbers:

1. Hangers

PIPE SIZES	HANGER
5" and smaller	260, steel clevis
6" and larger, or as detailed	171 (pipe roll with dual hanger rods)
Bare copper	CT 99 (copper plated), or CT 99C (plastic coated)

2. Stands

PIPE SIZES	FIGURE NUMBER
All sizes	274, adjustable prior pipe roll

F. Hangers and stand supports for all horizontal cold water lines shall be sized for the outside diameter of the insulated pipe. Insulation shall pass unbroken through the hanger and shall rest on insulation protector saddles fabricated from 20 gauge sheet steel. Saddles shall be 9" long and have an arc of approximately 120 degrees. Saddles may be job made or shall be Grinnell Figure No. 167.

G. Brackets for downfeed piping serving heating units shall be Fee and Mason No. 302 split ring extension hanger. Brackets shall be sized to fit the bare pipe.

H. Vertical piping shall be supported by Figure 261 riser clamps at each floor.

I. Steel supports, other than designed building structural members, required for support of piping installed under this Section of the Specifications, shall be furnished and installed under this Division.

J. Piping supports shall not be attached to any equipment having moving parts. Supports shall be independent of equipment by brackets to the floor, walls, or columns.

K. Maximum spacing of supports shall be as follows:

PIPE SIZES	SPACING
1 1/2" and smaller	8'
2" and larger	8'
Polyethylene (or polypropylene)	
Piping	5'
Cast iron pipe	Each length or 8' maximum

L. Comparable hangers, supports, etc., as manufactured by Fee and Mason, Elcen, or B-Line, Gateway will be considered equal to the Grinnell products providing the specifications are fully met. ½" through 2" pipe shall have 3/8" diameter hanger rods; 2 ½" and 3" pipe shall have ½" diameter hanger rods; 4" through 5" pipe shall have 5/8" diameter hanger rods; 6" through 8" pipe shall have ¾" diameter hanger rods.

1.7 PIPE AND PIPE FITTINGS

A. General

1. The General Conditions, Special Conditions, and the applicable portions of Division 1 of the Specifications are a part of this section.

2. The Contractor for this work shall be governed by any Alternate Bids requested insofar as they affect his work.

B. Scope

1. This work includes the furnishing of all pipe and pipe fittings, materials, equipment, labor, etc., necessary for the proper and complete installation of systems and equipment as shown on the drawings and/or herein specified.

C. Installation

1. All pressure pipe installations and fabrication shall be in accordance with the procedures established in the American Standard Code for Pressure Piping and the best recognized current practices of the trade. In addition, the same code shall be fully applicable to all services included herein. All sanitary soil, waste and vent piping shall be installed in accordance with the latest revisions of the Kentucky State Plumbing Code.

2. In general, all piping shall be installed concealed except in mechanical, storage, janitor rooms and etc., and shall be installed underground or beneath concrete slab on grade only where indicated. All lines at ceilings shall be held as high as possible and be run to avoid conflicts with other trades, and to facilitate the owner's use and access.

3. Piping shall be installed straight and true, parallel or perpendicular to walls, with approved offsets around obstructions. Standard pipe fittings shall be used for changing direction of piping. No mitered joints or field fabricated pipe bends are permitted, except that copper pipe 1/2" and smaller may be bent in the field with approved bending equipment, if authorized by the Engineer.

4. Tee connections for welded pipe shall be made up 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, socket o let, or thread o let type fitting may be used for the side outlet in place of reducing tees only where the outlet is 2/3 of the run size, or smaller.

5. Short radius elbows may be used only where specifically authorized by the Architect/Engineer.

6. Unless otherwise indicated on the Drawings, all piping shall be pitched to permit drainage and venting. Air vent lines shall be provided in all liquid under pressure at all high points and at drops in direction of flow and where otherwise indicated. Air vent valves in all water lines, except potable water lines, shall be manual type unless otherwise indicated and be piped to drain or as directed by the Architect/Engineer. All vents shall be installed easily accessible locations with extensions to cabinet face where installed in radiation cabinets.

7. Piping shall be erected to provide for expansion and contraction without harmful strain to building structural members, pipe and vibrating equipment. Provide expansion bends or devices other than those indicated if, in the opinion of the Engineer, such devices are required by field conditions. Unless indicated otherwise, expansion bends are preferred to the use of expansion joint and shall not be substituted without the permission of the Engineer. Expansion bends in steel pipe shall be made using long radius welding elbows. Expansion loops shall be cold sprung and welded into the line, which shall be anchored before removing the spreader from the expansion U bends.

8. Expansion loops, swing ells of joints shall be installed where indicated and where specified herein. Design and installation of expansion joints shall be such as to provide for the stresses and strains imposed by connected piping and vibrating equipment and by operating pressures, test pressures and temperatures.

9. Ream all pipe ends and thoroughly clean dirt, chips and foreign matter from all piping, fittings, valves and other accessories before joint connections are made.

10. Screwed joints shall be made with oil and graphite or other approved compound. Joint compound shall be applied to the male threads only and care shall be exercised to prevent compound from reaching the interior of the pipe.

11. Screwed unions, welded unions or bolted flanges shall be provided as required to permit convenient removal of equipment, valves and piping accessories from the pipe system. In concealed locations, union nuts shall be center punched to prevent loosening from vibration. Leave adequate clearances for rodding, motor lubrication, etc.

12. Dielectric insulating unions or dielectric couplings shall be used wherever the adjoining materials being connected are of dissimilar material such as connections between copper tube and steel pipe.

13. Flanged joints shall be assembled with appropriate flanges, gaskets and bolting. The clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system. Flange faces shall be parallel and the bores concentric; gaskets shall be centered on the flange faces so as not to project into the bore. Bolting shall be lubricated before assembly to insure uniform bolt stressing. The flange bolts shall be drawn up and tightened in staggered sequence in order to prevent unequal gasket compression and deformation of the flanges. Wherever a flange with a raised face is used, the face shall be machined down to a smooth matching surface and a full face gasket shall be used.

14. Piping shall not be installed in locations subject to freezing; if in doubt, consult Engineer.

15. Eccentric reducers shall be used where required to permit proper drainage and venting of pipe lines; bushings are not permitted for this purpose. Drain valves shall be provided in all piping systems at low points and otherwise indicated. Blow off valves shall be provided in all piping at strainers where indicated hereinafter.

16. Provide pipe anchors as noted hereinbefore. Anchors shall consist of heavy steel collars welded to pipe and secured to the building structure to prevent movement of piping. All anchors shall be approved by the Architect/Engineer, before installation is started.

17. Condensate drain lines from cooling equipment shall be pitched and installed with brass plug cleanouts at each change in direction and/or at 20' intervals.

18. At each fixture and piece of equipment, provide appropriate shutoff valves and unions.

19. Materials shall be new and of the best grade and quality; workmanship shall be first class in every respect.

20. All thread shall conform to ANSI B16.3 for American Standard Taper Pipe Threads.

21. Chain or wire rope slings for handling pipe shall not be allowed unless padded to prevent marring of protective coating on pipe.

22. Lock type mechanical joints shall be made up tight, but shall allow for 1/8" contraction of the pipe at each joint.

23. Pipe shall be kept clean at all times, especially the interior and joint surfaces. When no work is in progress the pipe shall be capped or plugged to prevent the entrance of water or dirt. Before any cast iron or ductile iron pipe is laid, it shall be lightly tapped with a hammer while suspended above the ground; sound pipe will emit a clear ring sound, unsound pipe will emit a dull sound. Unsound pipe shall not be laid and shall be rejected.

24. All steel surfaces such as tie rods, flanges, bolts, nuts, etc., to be buried in the earth, shall be protected with a 1/4" minimum coating of filtrated bituminous compound after installation and prior to backfill. Protective coating shall be Sonneborn "Hydrocide Mastic", Lambers "Waterban #60M", Emulsified Asphalts "Multiseal" or equivalent. Application shall be in strict accordance with manufacturer's directions. All existing steel surfaces uncovered by excavation shall be thoroughly cleaned and treated in a like manner.

25. Plastic piping shall not be installed in any facility in a manner that would require penetration of one hour or greater fire resistive wall, ceiling or shaft. Unprotected plastic piping shall not be installed in any area that is used for the transfer of environmental air in accordance with the Kentucky State Building Code.

26. Solder joints for water systems; use 95/5 tin antimony (50/50 solder not acceptable).

27. Material shall be new and of the best grade and quality; workmanship shall be first class in every respect.

28. All piping must be installed to allow proper access to equipment, access doors, valves, motors, etc.

D. Condensate Drains

1. Condensate Drain Lines from air conditioning equipment, pumps etc., shall be Schedule 40 PVC or Type "L" copper; except piping in plenum returns and relief air plenums or to exterior must be copper.

2. Fittings to be PVC with solvent weld glued fittings; or wrought copper with 95/5 solder. Connections must be made in strict accordance with manufacturer's requirements.

3. Elbows to be long sweep type.

4. Provide "Y" cleanouts at 20' 0" intervals in mains and at all changes in direction with open ends plugged with brass screw plugs.

5. Solder shall be 95/5 tin antimony conforming to ASTM B 32, Grade 5A. (50/50 solder not acceptable).

6. Condensate piping under slab shall be standard weight cast iron (min. size of 2") with floor clean outs as indicated or at all 90 degree ells.

E. Refrigerant Piping and Specialties

1. Refrigerant piping shall be Type ARI hard copper with wrought copper sweat fittings. Solder joints for refrigerant systems if required; use silver brazing alloy with 1100 degree minimum melting point with approved flux; brush or wipe all joints; use nitrogen admitting method during fabrication. All 90 degree ells must be long sweep radius type.

2. Install refrigerant piping in strict accordance with the Safety Code for Mechanical Refrigeration and Code for Refrigerant Piping and the VRV equipment manufacturer. All piping shall be sized and installed in strict accordance with the equipment manufacturer's recommendations. Submit refrigerant piping schematic drawings to Engineer for review prior to installation. Drawings must indicate all pipe sizing and refrigerant accessories. Provide solenoid valves and expansion valves and install as directed by the unit manufacturer.

F. Polyvinyl Tape

1. Johns Manville, Minnesota Mining and Mfg., Union Carbide or equivalent; similar to Johns Manville No. V 20; 0.02" thick; polyvinyl.

G. Escutcheons

1. Escutcheons shall be Beaton and Caldwell; Carpenter and Patterson; Fee and Mason or approved equivalent. Escutcheons shall be set screw type for permanent installation.

2. Exposed bare and insulated piping passing though floors, walls, or ceilings of finished rooms shall be provided with chrome plated escutcheons. Plates shall be of the split, hinged type of sufficient outside diameter to amply cover up the sleeve openings for the pipe. Beaton and Caldwell No. 10.

3. The Contractor's attention is called to the fact that most of the escutcheons will be installed around insulated pipe. It will be necessary that the plates fit snugly around the insulation and will be firmly held in place. Insulation shall not be cut or notched in any way.

4. Provide chrome plated escutcheons for hanger rods in finished ceilings. Carpenter and Patterson #182.

H. Flexible Pipe Connectors

1. Flexible heavy duty neoprene/nylon connections shall be as manufactured by Mason, Flexonic Company, Korfund, Keflex or approved equivalent, and shall be 300 lb. working pressure minimum, suitable for temperature of application. Connectors shall have flanged end connections in sizes larger than 2". Flexible connectors shall be furnished and installed at each base mounted pump connection and where indicated. Provide lengths as indicated or recommended by the manufacturer. Flexible connectors shall be equivalent to Mason Model MFTNC twin-sphere connectors.

2. Heat pump flexible flame retardant type hoses shall be stainless steel braided over a synthetic polymer liner. Hoses shall meet or exceed the ASTM-D380-83 standard, and withstand working pressures of 375 psi (1/2"), 300 psi (3/4"), 225 psi (1"), 200 psi (1¼"), 175 psi (1½") at 250 degrees F. Hoses shall meet or exceed flame retardant testing per standard UL #723, NFPA #225, ANSI 2.5, UBC 42-1, ASTM-E84A. Minimum hose length 24". Flexible hoses shall be as manufactured by Griswold, P.S.I. or Design Flow Inc.

I. Insulating Dielectric Unions and Couplings

1. Epco type GX or DX as required, Walter Vallett Co., Capitol Mfg. Co., Victaulic, or equivalent, for use in connecting dissimilar metals.

1.2 VALVES

A. Installation

1. Where required for ease of operation of valves and wherever elsewhere required by the Drawings, valves shall have extension stems.

2. All valves shall be of the same manufacturer insofar as possible.

3. In no case shall valves be installed with the stems below the horizontal.

4. Valves located above ceilings and in accessible pipe chases shall be provided with access panels.

5. Valves for water service shall be built for not less than 125 lbs. W.S.P., 200 lbs. W.O.G., 450 degrees F flanged valves shall have standard weight flanges.

6. Provide the required wrenches or handles to operate valves and cocks. A set of wrenches of handles shall be mounted on a finished plywood panel and installed in the Boiler Room where directed.

7. Brass valves for use in copper piping 1/2" and larger shall have screwed or flanged ends with screws or companion flanges and adapter to suit. Brass valves smaller than 1 1/2 inches may be soldered but extreme care must be taken to prevent heat damage to valve. Comply strictly with manufacturer's requirements.

8. Valves shall be the same size as the line in which they are installed unless otherwise noted.

9. The following paragraphs mention usually Nibco and Dezurik No.'s to establish desired quality. Comparable valves by Milwaukee, Grinnell, Crane, Kennedy, Lunkenheimer, Walworth, Jenkins, Jamesbury, Apollo, Keystone, Kunkle, Mueller, Pegler, Homestead, Red/White and Stockham will be considered equal.

B. Globe Valves

1. Globe valves, 2" and smaller, Nibco No. T 235 Y, screwed, bronze, renewable TFE disc, rising stem, 150 lbs. steam/300 lb. WOG working pressure, and union bonnet.

2. Sizes 2 1/2" and larger Nibco No. F 718 B, I.B.B.M., flanged with flanged bonnet and yoke, outside screw and yoke, renewable bronze disc, 125 lb. steam/200 lbs. WOG working pressure.

C. Swing Check Valves

1. Check valve 2" and smaller, Nibco No. T 413 Y, screwed, bronze, swing check, renewable TFE disc, 125 lbs. steam/200 lbs. WOG, working pressure.

2. Check valve 2 1/2" and larger, Nibco No. F 918 B, I.B.B.M., flanged, with bolted cap, swing check, renewable seat and disc, 125 lbs. steam/200 lbs. WOG, working pressure.

D. Butterfly Valves

1. Butterfly valves in ANSI Class 125, 2" through 20" shall be wafer or lugged style. Valve body shall be cast iron (ASTM A-126, Class B). Lugged valves shall have a mechanically retained seat and shall provide tight shut-off on dead-end or isolation service without the use of downstream flanges. Discs shall be bronze or cast iron with electroless nickel plating or welded nickel edge. Shafts shall be 416 stainless steel and be supported on three self-lubricating bronze or TFE coated stainless steel bearings. Shaft seals and seats shall be EPDM. Valve seats shall be molded to a rigid reinforcing ring. Valves 6" and smaller shall have a 10-position locking lever handle, valves 8" and larger shall have a totally enclosed weatherproof gear operator. Valves are to be Dezurik Fig. 632/8GS or equivalent.

E. Ball Valves

1. Nibco No. T 585 70; anti blowout stem; Body shall be bronze or brass, two piece, with screwed ends. Ball shall be hard chromium plated bronze or brass. Seats, stem packing seal and thrust washer shall be RTFE. Valve handle and nut shall be cadmium or zinc plated steel, with non heat vinyl grip. Valve shall be operated from full open to full closed by turning the valve handle one quarter turn (90 degrees) and the valve handle shall indicate ball position. Valve shall be

suitable for flow in either direction. Valve assembly shall be rated 150 P.S.I. SWP and 600 P.S.I. WOG, for 1/4" through 2" sizes; valves shall be full port 1/4" thru 1" and conventional port 1 1/4" thru 2".

F. Relief Valves

1. Provide relief valves for all pressure systems including domestic hot water heaters, boilers, storage tanks, water source heat pump loop piping as required by manufacturers, prevailing codes or insurance requirements.

2. Relief valves for domestic water heaters and storage tanks shall be combination pressure and temperature type with pressure setting of 125 psi and temperature setting of 210 degrees F.

3. Discharge these relief valves over to floor drain or as shown and noted on Drawings.

4. All relief valves shall be lever handle operated, A.S.M.E. approved as manufactured by Watts, McDonnell Miller, Kunkle, or equivalent. Coordinate relief valve setting and sizing with equipment manufacturers.

5. Water heaters and boilers shall be provided from the factory with code approved relief valves sized, located and installed in strict accordance with code and manufacturer's requirements.

6. Heat pump loop relief valve shall be equivalent to Kunkel Figure 137; size 1 1/2"; 95 psi; 1,750,000 max. btu/hr.

G. Silent Check Valves

1. Silent check valves 2" and smaller, Nibco No. T-480Y; screwed; 125 p.s.i. steam/250 p.s.i. WOG; 3 lb. stainless steel spring; bronze body; stainless steel stem; TFE disc and seat ring.

2. Silent check valves, 2 1/2" and larger, Nibco No. W-960 (wafer) or F-960 (flanged); cast iron body; type 302 stainless spring; bronze disc; Buna N bonded to bronze seat; 250 lb. W.O.G.

3. All check valves at pumps shall be silent type.

H. Gauge Cocks

1. Ashcroft No. 1092; 150 PSIG maximum working pressure; bronze; 1/4" screwed connections; tee handle.

2. All pressure gauges shall be installed with a gauge cock.

I. Flow Measuring Indicators and Balancing Valves

1. Flow Indicators

a. Flow indicators shall be Flowset Venturis, Armstrong Venturis, Gerand Venturis. They shall be line size unless otherwise indicated.

b. On the return side of the coil, or as shown on the mains 4" and smaller, provide a Flowset Accusetter or equivalent balancing assembly. The assembly shall include a constant orifice Flowset Venturis flow sensor with P/T ports; and connected downstream of the Venturis, a ball balancing valve with memory stop. The accuracy of the system shall be

+2%. Provide a minimum of 24" straight pipe run on each side of balancing valve/flow indicator assembly.

c. For piping mains larger than 4", provide Flowset Venturis or equivalent, cast steel flow indicator with grooved or flanged connections and P/T ports. Downstream of the flow indicator, or as noted on the drawings, provide Dezurik eccentric balancing plug valve, Homestead or equivalent.

d. These balancing valves are not required at equipment locations where self-balancing valves are used.

2. Self-Balancing Constant - Flow Control Valves (For Heat Pump Units)

a. Flow control valves shall be factory calibrated, direct acting, automatic pressure compensating type. Each valve shall limit flow rates to within +5 accuracy, regardless of system pressure fluctuations. Valve control mechanism shall consist of a tamperproof, stainless steel or nickel plated brass cartridge assembly with open chambers and unobstructed flow passages. Cartridge assembly shall include a self-cleaning, spring-loaded moving cup guided at two separate points and shall utilize the full available differential pressure actuate without hysterisis or binding. Each valve to be provided with a metal tag, chain and stamped for system identification. Valves shall be provided with pressure/temperature test valves to test temperature and pressure drops across the valves. Flow control valves shall be as manufactured by Griswold Controls, Autoflow, PSI or equivalent.

b. Valve 1/2" thru 1-1/2" shall be equivalent to Griswold threaded mini Series or Auto Flow FV Series, provided complete with P/T plugs union and ball valves; 450 psi at 200 degree F. The valve pressure range shall be 2 - 32 psi.

c. Valves 2" and 2-1/2" shall be equivalent to Griswold 3542 series threaded flange type; 300 psi at 275 degree F; AISI type 300 series passivated stainless steel parts; gray-iron ASTM A126-61-T internal class 30 body material (2-32 psi).

d. Flow control valves shall be line size unless otherwise indicated and shall have set gpm flow rate as indicated on equipment water coil schedules; see Section 236100 of Specifications. Valves shall be installed on return side of coil. See details on Drawings. Provide piping reducer at heat pump piping connection as required.

J. Backflow Preventer for Heat Pump Loop and Water System

1. Backflow preventer shall be similar to Watts Series 909 reduced pressure principal backflow preventer, Hersey, Wilkins or equivalent. Provide with funnel for drain connection. See plans for line sizing unless otherwise indicated.

K. Balancing Valves

1. Balancing valves 4" and smaller shall be ball valves as specified herein. Provide valves with extension stems to ensure proper operation over pipe insulation. Valves shall have 100% dead-tight shut-off and adjustable memory stops.

1.3 MISCELLANEOUS H.V.A.C. SPECIALTIES

A. Thermometers

1. Weiss No. 9VS type vari-angle 9" mercury filled heavy duty type; Marshalltown, Ashcroft, Marsh, or equivalent, Accuracy within 2% of scale span. Brass 3 1/2" (min.) stem complete with separable socker. Stem and socket must be of adequate length to give accurate temperature readings. Install in piping system in strict accordance with manufacturer's requirements. Increase pipe sizing at thermometer as required. Range 30 to 240 degrees F. for hot water piping, and 0 120 degrees F, for heat pump loop water, unless other standard range selected upon submittal. Contractor shall adjust case for readability from floor line.

B. Pressure Gauges

1. Weiss Series UG 1, Ashcroft, Marsh, Marshalltown or equivalent. 4 1/2" dial, range selected upon submittal; with maximum pointer; brass bourdon tube and socket; 1% accuracy.

2. All pressure gauges shall be installed with lever handle gauge cock and brass straight coil siphon tube.

C. Pressure/Temperature Plugs

1. Sisco Number BNO 025, P.O. Box 197, Riverton, N.J. or approved equal. P/T plugs shall have 1/2" NPT size; brass body/cup material; Nordel Valve Core Material; 300 degrees F temperature rating.

2. Install as a minimum a P/T plug at the general location of all thermometers and pressure gauges; and at the supply and return piping of all equipment. Reference mechanical drawings for additional locations of P/T plugs.

D. Strainers

1. Strainers shall be Y type equal to Leslie, Illinois, or Mueller. Sizes 2 1/2" and larger shall be flanged; sizes 2" and smaller shall be screwed.

2. Water strainers shall be cast iron or brass, designed for 125 lb. steam/200 lbs. WOG working pressure.

3. Strainers shall have a free area of strainer screen a minimum of twice the area of the adjoining pipe. Strainer baskets shall be fabricated from stainless steel or monel sheet metal; baskets shall have 0.045" (3/64") perforations for water service.

4. Strainers shall have short nipple and ball valve provided on blow off, sized the same as blow off size. Where strainers are located more than 3' above floor, blow off line shall be offset to wall or column and extended down to 3' level and then valve provided. Provide nipple and cap on smaller strainers, in addition to ball valve, at AHU's, FCU's and UV's for easy maintenance blow-off.

E. Manual Air Vents

1. Mains are detailed on drawings.

2. Terminal units to be Dole, Taco or equivalent. Dole No. 14A Key Air Valve.

F. Air Separator

1. Air separator shall be Thrush, Armstrong, Wheatley, Taco, or Bell & Gossett "Rolairtrol", flanged, with integral strainer. A blow down connection shall be provided with a ball valve to facilitate routine cleaning of unit. Separator shall be

designed to operate at 125 psi water pressure and shall be A.S.M.E. constructed and stamped. Unit shall be line size, unless otherwise indicated. Provide air separator with high volume air eliminator similar to Thrush #720.

G. Expansion Tanks (Diaphragm Type)

1. Expansion tanks shall be Bell & Gossett Model B-200, Taco, CA Series, Amtrol "L" Series, Wessels, Wheatley or equivalent; with removable and replaceable heavy-duty butyl rubber bladder; ASME constructed, 125 PSI maximum design pressure and 240 degrees F maximum design temperature. Set air pressure in tank at 18 PSI prior to connection to system.

2. See schedule on Drawings for capacities.

H. Automatic Air Eliminator

1. Automatic air eliminator shall be B & G or Amtrol Model No. 720, cast iron body; 150 psi maximum working pressure; 250 degrees F maximum working temperature.

I. Automatic Air Vent

1. Automatic air vent shall be Hoffman No. 79, Amtrol, Taco or equivalent. Provide with tap at top for venting to drain.

END OF SECTION 231110

SECTION 233110 - AIR DISTRIBUTION

1.1 DUCTWORK AND ACCESSORIES

A. General

1. The General Conditions, Special conditions and the applicable portions of Division 1 of the Specifications are a part of this Section.

B. Scope

1. This work includes the furnishing of all labor, materials, equipment, etc. necessary for the proper and complete installation of ductwork and accessories as shown on the Drawings and/or herein specified.

C. Shop Drawings

1. Shop drawings shall be submitted on all ductwork accessories including name of manufacturer, materials of Construction, Manufacturer's details of installation, connections to other work, fastening, supports, anchors, etc. Shop Drawings shall include all equipment accessories and attachments incidental to a proper and complete installation.

2. Shop drawings shall be submitted, as a minimum, on the following items: flexible connections, manual dampers, damper quadrants, splitter dampers, inspection door and latches; turning vanes, control dampers, fire dampers (include sleeve installation instructions per manufacturer recommendations); flexible ductwork.

D. Quality Control

1. Provide all materials, labor accessories, etc., for the fabrication and installation of all ducts and sheet metal work as shown on the Drawings and/or as specified herein. Where construction methods for various items are not indicated on the Drawings or specified herein. Where construction methods for various items are not indicated on the Drawings or specified herein all such work shall be fabricated and installed in strict accordance with the recommended methods, metal gauges, hanging procedures, access door and accessory installations, etc., as outlined, the latest edition of NFPA Pamphlet No. 90A, SMACNA's Duct Manual and Sheet Metal construction for Ventilating and Air Conditioning System, SMACNA's Duct Manual for high velocity systems, and the Manual of Recommended practice of Industrial Ventilation published by the American conference of Governmental Industrial Hygienists. These references and Plate Numbers shall be used by the Engineer for required sheet metal thicknesses and final acceptance of methods of fabrication, hanging accessories, etc. all equipment furnished by manufacturers shall be installed in strict accord with their recommended methods.

E. Miscellaneous Materials, Accessories and Requirements

1. Flexible Connections

a. Provide Dyro Dyne, Ventfabrics, U.S. Rubber or equivalent conforming to NFPA Pamphlet 90A; neoprene coated glass fabric; 20 oz. for low pressure ducts secured with ship locks. Provide at all duct connections to fans, air handling units, etc.

2. Manual Dampers

a. Dampers in round ductwork shall be similar to Ruskin Model MDR525, Whiz Air, Creative Metals, Louvers and Dampers, American Warming, Cesco or equivalent round manual balancing damper; frame 20 gauge galvanized steel; blade 20 gauge galvanized steel; 3/8" axle shaft extending thru both sides of ductwork and factory mounted heavy duty locking hand quadrant; bearings shall be brass, stainless steel or molded synthetic on both sides of ductwork.

b. Dampers in rectangular ductwork 12" in depth or less similar to Ruskin Model MD25 manual balancing damper; frame 20 gauge galvanized steel; blade 20 gauge galvanized steel; 3/8" square axle shaft extending thru both sides of ductwork and factory mounted heavy duty locking hand quadrant; bearings shall be brass, stainless steel or molded synthetic on both sides of ductwork.

c. Dampers in rectangular ductwork of greater than 12" in depth shall be similar to Ruskin Model MD35 round manual balancing damper; frame 16 gauge galvanized steel; blade 16 gauge galvanized steel; 3/8" square axle shaft extending thru both sides of ductwork and factory mounted heavy duty linkage and locking hand quadrant; bearings shall be brass, stainless steel or molded synthetic on both sides of ductwork.

d. Comparable dampers as manufactured by Cesco, Arrow, Dowco, Air Balance, Creative Metals, Louvers and Dampers or equivalent.

3. Damper Quadrants

a. Quadrants shall have indicators showing open and closed positions, and shall be Ventfabrics, "Ventlock".

b. Dampers with shaft length 12" or less No. 620 for base ductwork and No. 637 for insulated ductwork.

c. Dampers with shaft length longer than 12" No. 637.

4. Splitter Dampers

a. Fabricate from 16 gauge steel with a hemmed leading edge; trailing edge shall be pivoted on a rod or hinges; install in accordance with the latest edition of SMACNA Low Velocity Manual. Secure rod to leading edge of damper and extend rod through side of ductwork using Ventlok No. 603 ball joint bracket with set screw.

5. Miscellaneous Accessories

a. Test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA and/or as indicated. Test openings shall be placed in the inlet and discharge of all centrifugal type fans and fan sections of air handling units at the end and middle of all main trunk ducts and where indicated.

6. Turns

a. Turning vanes shall be installed in low pressure duct in all square turns and where indicated and shall be fabricated as recommended by SMACNA or shall be Barber Colman Company, Titus, Airturns, or equivalent. No projecting edges will be permitted inside ducts. Air extractors shall be utilized at each supply diffuser face where the take off

to the diffuser is at a 90 degree angle. Radius elbows shall be made with the radius of the center line of the duct equivalent to 1.5 times the width of the duct; where a smaller radius is required use guide vanes.

7. Control Dampers

   a. Provide any automatic control dampers not supplied by others; install all dampers.

8. Crossbreaking

   a. Crossbreak all low pressure ducts in excess of 18" in width or depth and internally lined ducts over 18" shall be constructed of hemmed S Slip, or 1 inch bar slips on 5' 0" centers according to SMACNA Plate No. 7.

9. Duct Hanging

   a. All duct hangers in direct contact with galvanized duct shall be galvanized steel; exposed ductwork shall be hung with Ductmate Clutcher cable.

   b. Where ducts are situated in unconditioned areas and are required to have insulation with a vapor sealed facing, the ducts shall be supported on trapeze hangers. The hangers shall be spaced far enough out from the side of the duct to permit the duct insulation to be placed on the duct inside the trapeze. Under no circumstances shall duct hangers penetrate the vapor sealed facing.

   c. All other duct hangers may be directly attached to ducts. Ducts shall be hung by angles or straps as listed in the following schedule. Rods, straps or angles may be used in trapeze hangers. hangers shall be in accordance with the following schedule, except that there shall be no less than one set of hangers for each section of ductwork. Ductwork shall not be hung or supported from metal deck.

      i. Where elbows or tees are installed for changes in direction, hangers shall be provided. No ductwork shall rest on the Building structural system.

Cross Sectional Area	Hanger Strap	Hanger Angle	Hanger Rod	Hanger Set Spac. Maximum
0.1.5 sq. ft.	1"x22 ga.	1"x1"x1/8"	3/8"	8'0"
1.6 3.0 sq. ft.	1"x22 ga.	1"x1"x1/8"	3/8"	8'0"
3.1 6.0 sq. ft.	1 1/2"x18ga	1"x1"x1/8"	1/2"	8'0"
6.1 sq. ft. & larger	2"x18 ga.	1 1/2"x1 1/2"x1/8"	1/2"	6'0"

      ii. Where trapeze hangers are used, the bottom of the duct shall be supported on angle sized as follows (for round cuts, the angle shall conform to the bottom 120° of the duct).

Dia. of Duct	Width of Duct	Bottom Angle Sizes
0" 34"	0" 30"	1"x1"x1/8"

35" & larger	31" 48"	1 1/2"x1 1/2"x1/8"
35"	49" 72"	1 1/2"x1 1/2"x3/16"
	73" 96"	2"x2"x1/4"
	97" & up	3"x1/4"

iii. All hangers shall be sufficiently cross braced to eliminate, in the opinion of the Architect, excessive sway. Whatever ductwork contains filter sections, coils, fans or other heavy equipment (excluding registers, grilles, diffusers, splitter dampers, etc.) such equipment shall be hung independently of the ductwork, with rods or angles of sizes adequate to support the load.

10. Special Duct Hanging Conditions

a. In the event ductwork interferes with suspended ceiling support hangers, provide cross members from hangers affected. These cross members shall be of reinforcing steel or furring channels and shall run under ductwork in question from which additional ceiling hangers shall be supported.

11. Duct Sizes

a. Duct sizes indicated on Drawings are net free areas required. Internally lined ducts where required shall be increased in size to fully compensate for internal insulation thickness.

12. Plenums

a. Plenums shall be sturdily constructed with structural iron stiffeners as required to insure a vibration free system.

13. Ductwork Access Doors

a. Ductwork access doors shall be installed at the locations and of sizes shown on the Drawings and as required for all equipment access. Hardware for doors shall be Ventfabrics, Young Regulator Company, United Sheet Metal, Kees, Air Balance, Buckley or Ruskin equivalent to Ventfabrics, "Ventlok" as follows:

i. Small doors (16" maximum side, or smaller) shall have No. 100 Latches.

ii. Large Doors (18" side or Larger) shall have No. 310 latches.

b. Where doors are installed in insulated ductwork, doors shall be of double panel construction, insulated internally with a minimum of 1" glass fiber insulation, and set flush with outside surface of duct insulation.

F. Low Pressure Air Distribution Ductwork

1. Sheet Metal Duct (Rectangular and Round)

a. All low pressure supply, return, outside air and exhaust air ductwork for the air distribution systems shall be galvanized sheet steel complying with ASTM A 527, lock forming quality; with G90 zinc coating in accordance with ASTM A 525. Provide internal insulation as specified

in Insulation Section of this Specification and/or as indicated on the Plans.

b. Sheet metal duct drops to diffusers, registers and/or grilles shall be connected to duct collar with sheet metal screws 3" c/c.

G. Flexible Duct (Low Pressure)

1. Provide where indicated on Drawings flexible ductwork of a type suitable for the application as hereinafter indicated. The duct must comply with the latest NFPA Bulletin 90A and be listed as Class 1 connector or duct material; duct connections and terminations shall be per manufacturer's directions. U.L. Standard 181 where applicable. Flexible duct shall be as manufactured by Wiremold, United, Clevaflex, Flexmaster, Thermaflex, Omni or equivalent.

2. Ductwork shall be equivalent to Wiremold type WK airtight polyester core with galvanized wire helix; 1 1/2", 3/4 lb. density fiberglass insulation blanket, and aluminized reinforced vapor barrier (no vinyl).

3. Flexible ducts shall be installed with joints made using approved metal banding methods as detailed on the Drawings. Pan-duit straps or similar fastening products are not acceptable. Ducts shall be limited to 5' in length.

H. Auxiliary Drain Pans

1. Provide 22 gauge sheetmetal auxiliary drain pan under all above ceiling water source heat pumps. See detail on drawings. Coordinate with other trades and structural conditions. Provide moisture sensor in auxiliary pan to disable unit operation. Refer to controls specification.

I. Fabric Backdraft Dampers

1. Dampers shall be fabric type mounted at an angle on expanded metal support similar to Ruskin, Vent Products, Reliable or equivalent.

J. Duct Sealer

1. All joints and connections in the entire supply, return, outside air and exhaust sheet metal ductwork systems shall be sealed with a top quality grade of high pressure duct sealer. Duct sealer shall be similar to Hardcast Inc. IG 601 iron grip, United or R.V. Money "Money Saver Sealer;" U.L. listed; zero flame spread, fuel contribution and smoke development.

1.2 AIR DISTRIBUTION DEVICES

A. General

1. The General Conditions, Special Conditions and the applicable portions of Division 1 of the Specifications are a part of this Section.

B. Scope

1. This work includes the furnishing of all air distribution devices and labor, materials and equipment, etc., necessary for proper and complete installation of all air distribution devices as shown on the Drawings and/or herein specified.

2. The work of this Section consists of providing all labor, materials, equipment, and services for the fabrication or installation of all diffusers, grilles, louvers, intakes, discharges, and appurtenances in connection with heating, ventilating and air conditioning. Alternate selections will be accepted provided quality,

function and characteristics are equal. Shop drawings shall identify and list all characteristics of each device as scheduled herein.

C. Registers, Grilles, and Diffusers

1. General

a. Registers, grilles and diffuser shall be one manufacturer. Model numbers specified are Krueger and are for design criteria only. Manufacturers offering products complying with requirements include:

Krueger	Hart & Cooley	Metal Aire
Anemostat	Reliable Metals	Nailor Industries
Titus	Carnes	Price
Tuttle & Bailey		

b. Provide required mounting frames, supports and attachments to mount registers, grilles and diffuser in ceilings, walls, floor or exposed conditions. Install surface mounted units without gap between unit and mounting surface. Lay in units shall rest evenly on ceiling channels or frames. Install registers, grilles and diffusers in symmetrical pattern consistent with ceiling systems, lighting fixtures, ceiling speakers and sprinkler heads where included.

c. Maintain maximum sound level of 30 NC at specified air flow.

d. Painted finishes shall be factory baked enamel unless otherwise specified. Primer coat finish shall be factory applied. Protect finish in shipping cartons until ready for installation.

e. Volume dampers shall be opposed blade, adjustable type with tight linkage and blade movement. Provide 2" extension on control rod to extend beyond insulation.

2. Capacities and Finish

a. See schedule herein and on Drawings.

END OF SECTION 233110

SECTION 233400A – HIGH-VOLUME LOW-VELOCITY FANS - POWERFOIL X3.0

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. The ceiling-mounted circulation fan is the model scheduled with the capacities indicated. The fan shall be furnished with standard mounting hardware and variable speed control to provide cooling and destratification.

2. The fan speed control system is the model scheduled with the capacities indicated. The fan shall be furnished with a wall controller and upper temperature sensor to provide speed control of up to four (4) Powerfoil®X3.0 or Powerfoil®X3.0 Plus Big Ass Fans.

B. Summary of Work

1. Installation of the fan, miscellaneous or structural metal work (if required), field electrical wiring, cable, conduit, fuses and disconnect switches, other than those addressed in the installation scope of work, shall be provided by others. Factory installation services are available through Big Ass Fans. Consult the appropriate installation scope of work for information on the available factory installation options, overview of customer and installer responsibilities, and details on installation site requirements.

2. Installation of the wall controller and upper temperature sensor, field electrical wiring, cable, conduit, fuses, and disconnect switches, other than those address in the installation scope of work, shall be provided by others. Factory installation services are available through Big Ass Fans. Consult the appropriate installation scope of work for information on the available factory installation options, overview of customer and installer responsibilities, and details on installation site requirements.

C. Manufacturer

1. Where Big Ass Fans is listed, other manufacturers offering equal product shall be considered. Any alternate manufacturers shall be approved by Engineer prior to acceptance of bid.

1.2 RELATED SECTIONS

A. 21 00 00 Fire Suppression

B. 23 00 00 Heating, Ventilating, and Air Conditioning (HVAC)

C. 26 00 00 Electrical

D. 23 09 13 Instrumentation and Control Devices for HVAC

E. 25 00 00 Integrated Automation

1.3 REFERENCES

A. National Fire Protection Agency (NFPA)

B. Underwriters Laboratory (UL)

C. Restriction of Hazardous Substances (ROHS)

D. International Organization for Standardization (ISO)

E. National Electrical Manufacturers Association (NEMA)

F. National Electric Code (NEC)

G. Occupational Safety and Health Administration (OSHA)

1.4 SUBMITTALS

A. Shop Drawings: Drawings detailing product dimensions, weight, and attachment methods.

B. Part 2 Product Data: Specification sheets on the ceiling-mounted fan and fan speed control system, specifying electrical and installation requirements, features and benefits, and controller information.

C. Revit Files: File provided for architectural design.

D. Installation Guide: The manufacturer shall furnish a copy of all operating and maintenance instructions for the fan. All data is subject to change without notice.

E. Schedule

1.5 QUALITY ASSURANCE

A. Certifications

1. The fan assembly, as a system, shall be Intertek/ETL-certified and built pursuant to the guidelines set forth by UL standard 507 and CSA standard 22.2 No. 113.

2. The fan shall be compliant with NFPA 13—Standard for the Installation of Sprinkler Systems, NFPA 72—National Fire Alarm and Signaling Code, and NFPA 70-2011—National Electric Code (NEC).

3. Controllers shall comply with National Electrical Code (NEC) and Underwriters Laboratory (UL) standards and shall be labeled where required by code.

B. Manufacturer Qualifications

1. The fan and any accessories shall be supplied by Big Ass Fans, which has a minimum of ten (10) years of product experience.

2. ISO 9001-certified

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver product in original, undamaged packaging with identification labels intact. The fan shall be new, free from defects, and factory tested.

B. The fan and its components must be stored in a safe, dry location until installation.

C. The wall control components shall be new, free from defects, and factory tested. The product is packaged in static shielding materials for ESD protection.

1.7 WARRANTY

A. The manufacturer shall replace any products or components defective in material or workmanship for the customer free of charge (including transportation charges within the USA, FOB Lexington, KY), pursuant to the complete terms and conditions of the Big Ass Fans Non-Prorated Warranty in accordance to the following schedule:

Airfoils	Lifetime (Parts)

Hub	Lifetime (Parts)
Motor	15 years (Parts)†
Gearbox	15 years (Parts)†
Light Kit	5 Years (Parts)
Variable Frequency Drive	15 years (Parts)†
Wall Control components	1 year (Parts)
All other fan components	15 years (Parts)†
Labor	1 year

† 15-year parts warranty only valid with factory installation; 7-year parts without factory installation. "Lifetime" means a period ending seven (7) years after Big Ass Fans discontinues manufacturing the product, as such period is defined by Big Ass Fans.

†† All reasonable costs of repair or replacement will be paid or reimbursed provided customer obtains pre-approval; full warranty contains details.

PART 2 - PRODUCT

2.1 MANUFACTURER

A. Delta T Corporation, dba Big Ass S, PO Box 11307, Lexington, Kentucky 40575. Phone (877) 244-3267. Fax (859) 233-0139. Website: www.bigassfans.com., or approved equal.

2.2 HIGH VOLUME, LOW SPEED FANS – BIG ASS FANS POWERFOIL®X3.0

A. Complete Unit

1. Regulatory Requirements: The entire fan assembly (without light kit) shall be Intertek/ETL-certified and built pursuant to the construction guidelines set forth by UL standard 507 and CSA standard 22.2.

2. Sustainability Characteristics: The fan shall be designed to move an effective amount of air for cooling and destratification in a variety of applications (including industrial and agricultural) over an extended life. The fan components shall be designed specifically for high volume, low speed fans to ensure lower operational noise. Sound levels from the fan operating at maximum speed measured in a laboratory setting shall not exceed 55 dBA. Actual results of sound measurements in the field may vary due to sound reflective surfaces and environmental conditions.

3. Good workmanship shall be evident in all aspects of construction. Field balancing of the airfoils shall not be necessary.

B. Onboard Fan Control

1. The onboard fan controller shall be constructed using a variable frequency drive (VFD) that is pre-wired to the motor and factory-programmed to minimize the starting and braking torques for smooth and efficient operation. The onboard controller shall be prewired to the motor using a short run of flexible conduit with a dedicated ground conductor to minimize electromagnetic interference (EMI) and radio frequency interference (RFI). A 15-ft incoming power cord shall be pre-wired to the controller with one of the following plugs: NEMA L6-20P Twist-Lock Plug, NEMA L6-30P Twist-Lock Plug, NEMA L15-20P Twist Lock Plug, NEMA L16-20P Twist-Lock Plug.

2. As an option, the architect or owner may upgrade to the "harsh environment package," which includes a seal for the weather-resistant onboard VFD enclosure and a motor with IP55 NEMA classification.

C. Airfoil System

1. The fan shall be equipped with eight (8) Powerfoil airfoils of precision extruded aluminum alloy. The airfoils shall be connected by means of two (2) high strength locking bolts per airfoil. The airfoils shall be connected to the hub and interlocked with zinc plated steel retainers.

2. The fan shall be equipped with eight (8) Powerfoil winglets on the ends of the airfoils and eight (8) AirFences™ positioned on the airfoils at the optimum location for performance. Both the winglet and AirFence shall be molded of polypropylene. The standard color of the winglet and AirFence shall be "Safety Yellow."

D. Motor

1. The fan motor shall be an AC induction type inverter rated at one of the following:

   a. 1725 RPM, 200–240/400–480 VAC, 50/60 Hz, three-phase

   b. 1725 RPM, 575–600 VAC, 50/60 Hz, three-phase

2. The motor shall be totally enclosed, fan cooled (TEFC) with an IP42 NEMA classification. A NEMA 56C standard frame shall be provided for ease of service. The motor shall be manufactured with a double baked Class F insulation and be capable of continuous operation in -30oF to 122oF (-34oC to 50oC) ambient conditions.

3. As an option, the architect or owner may upgrade to the "harsh environment package," which includes a motor with an IP55 NEMA classification. As part of the "harsh environment package," the onboard VFD enclosure is sealed for weather-resistant operation.

E. Gearbox

1. The fan gearbox shall be a NitroSeal™ Drive designed specifically for the Powerfoil X series. The gearbox shall include a high-efficiency, hermetically sealed, nitrogen-filled, offset helical gear reducer with two-stage gearing, a hollow output shaft, cast iron housing, double lip seals, high quality SKF Explorer Series bearings with crowned cages for optimal lubrication flow, and precision machined gearing to maintain backlash less than 11 arc-minutes over the life of the unit. Lubrication shall be high-grade, low-foaming synthetic oil with extreme pressure additives and a wide temperature range.

2. The gearbox shall be equipped with a hollow shaft threaded to accept a ¾" NPT fitting in which wiring, piping, etc., can be routed to below the fan. A standard junction box can be affixed to this hollow shaft to allow for installing optional features such as lights or cameras. The inclusion of the hollow shaft shall be specified at the time of order.

F. Mounting Post

1. The fan shall be equipped with a mounting post that provides a structural connection between the fan assembly and extension tube. The mounting post

shall be formed from A36 steel, contain no critical welds, and be powder coated for corrosion resistance and appearance.

G. Mounting System

1. The fan mounting system shall be designed for quick and secure installation on a variety of structural supports. The mounting yoke shall be of ASTM A-36 steel, welded construction, at least 3/16" thick, and powder coated for appearance and corrosion resistance. No mounting hardware or parts substitutions, including cast aluminum, are acceptable.

2. All mounting bolts shall be SAE Grade 8 or equivalent.

H. Hub

1. The fan hub shall be made of precision cut aluminum for high strength and light weight. The hub shall consist of two (2) aluminum plates, eight (8) aluminum spars and one (1) aluminum spacer fastened with a pin and collar rivet system.

2. The hub shall be secured to the output shaft of the gearbox by means of (10) high strength bolts. The hub shall incorporate five (5) safety retaining clips made of 1/4" (0.6 cm) thick steel that shall restrain the hub/airfoil assembly.

I. Safety Cable

1. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be Ø3/8" (1 cm) diameter and fabricated out of 7 x 19 galvanized steel cable. The end loops shall be secured with swaged Nicopress® sleeves, pre-loaded and tested to 3,200 lbf (13,345 N).

2. Field construction of safety cables is not permitted.

J. Wall Controller

1. Regulatory Requirements: The fan speed control system shall be compliant with NFPA 70-2011—National Electric Code (NEC).

2. Sustainability Characteristics: The system shall be designed to automatically control the speed of Big Ass Fans from the locations of the wall controller and upper temperature sensor to maximize energy savings and user comfort. The system shall be designed specifically for high volume, low speed Big Ass Fans, and receives information from user-determined settings and temperature sensors.

3. Good workmanship shall be evident in all aspects of installation.

4. The wall control shall be a digital keypad device with an internal temperature sensor. It shall be wall-mounted centrally within the fan zone at head height using two (2) provided 6-32 x 7/8" pan head screws and four (4) provided 6-32 countersink.

5. The wall controller shall be enclosed in a cast zinc cover measuring 3.86" (9.8 cm) x 7.25" (18.4 mm) x 1" (2.5 cm) and be made of heavy-duty steel.

6. The wall controller includes a Class II AC Adapter power cord.

7. The wall controller only provides a speed reference for the fan. Start and stop functions are controlled by the auxiliary controller.

8. The mounting location shall meet the requirements of OSHA standard 29 CFR 1910.303(g) for accessibility minimum clearances.

K. Upper Temperature Sensor

1. The upper temperature sensor shall be mounted in the upper portion of the fan zone either by using a provided I-Beam clamp, or by using four (4) provided mounting screws.

2. The upper temperature sensor shall measure 1.9" (4.8 cm) x 4" (10.2 cm) x 1" (2.5 cm).

L. Auxiliary Controller

1. The fan is equipped with an auxiliary controller capable of providing 100% control of all fan functions. The auxiliary controller shall be a digital keypad device mounted within a cast zinc cover. The cover shall be capable of mounting to a standard switch box.

2. Equipped with touchpad controls and an LED display for controlling the fan's direction, operation, speed, and programming. Communication between the fan VFD and auxiliary controller is by a standard CAT5 (or higher) Ethernet cable. The auxiliary control comes standard with 150 ft of factory-assembled CAT5 Ethernet cable.

3. Equipped with a simple diagnostic program to identify faults in the system. Provisions shall be made for retrieving fan operation and diagnostic data (fault messages) through the auxiliary controller.

M. Fire Control Panel Integration

1. Includes a 10–30 VDC pilot relay for seamless fire control panel integration. The pilot relay can be wired Normally Open or Normally Closed in the field.

N. Guy wires

1. Included for installations with extension tubes 4 ft (1.2 m) or longer to limit the potential for lateral movement.

PART 3 - EXECUTION

3.1 PREPARATION

A. Fan location must have a typical bar joist or existing I-beam structure from which to mount the fan. Additional mounting options may be available.

B. Mounting structure must be able to support weight and operational torque of fan. Consult structural engineer if necessary.

C. Fan location must be free from obstacles such as lights, cables, or other building components.

D. Check fan location for proper electrical requirements. Consult installation guide for appropriate circuit requirements.

E. Each fan requires dedicated branch circuit protection.

F. Route power to within six (6) feet of the wall controller location. If additional distance is needed to power the wall controller, consult the alternative wiring method instructions in the Installation Guide.

3.2 INSTALLATION

A. The fan shall be installed by a factory-certified installer according to the manufacturer's Installation Guide, which includes acceptable structural dimensions and proper sizing and placement of angle iron for bar joist applications. Big Ass Fans recommends consulting a structural engineer for installation methods outside the manufacturer's recommendation and a certification, in the form of a stamped print or letter, submitted prior to installation.

B. Minimum Distances

1. Airfoils must be at least 10 ft (3 m) above the floor.

2. Installation area must be free of obstructions such as lights, cables, sprinklers or other building structures with the airfoils at least 2 ft (0.61 m) clear of all obstructions.

3. The structure the fan is attached to shall be capable of supporting a torque load of up to 300 ft·lb (407 N·m) of torque

C. The fan shall not be located where it will be continuously subjected to wind gusts or in close proximity to the outputs of HVAC systems or radiant heaters. Additional details are in the Big Ass Fans 3.2 Installation Manual.

D. In buildings equipped with sprinklers, including ESFR sprinklers, fan installation shall comply with all of the following:

1. The maximum fan diameter shall be 24 ft (7.3 m).

2. The HVLS fan shall be centered approximately between four adjacent sprinklers.

3. The vertical clearance from the HVLS fan to the sprinkler deflector shall be a minimum of 3 ft (0.9 m).

4. All HVLS fans shall be interlocked to shut down immediately upon receiving a waterflow signal from the alarm system in accordance with the requirements of NFPA 72 - National Fire Alarm and Signaling Code.

E. The wall control shall be installed by a factory-certified installer according to the Installation Guide.

F. The customer shall supply 2-conductor shielded cable (18-22AWG stranded) to connect the wall control components to the fan's variable frequency drive. The maximum distance between the wall controller and the upper temperature sensor shall be 1000 ft (305 m).

G. Installation areas must be free of obstructions such as lights, cables, sprinklers, or other building structures.

H. The components of the wall control must not be mounted adjacent to or above radiant heaters, near HVAC ventilation intakes or exhausts, on poorly insulated exterior walls, in roof decking, or near radiant heat sources, and must be mounted so that they are exposed adequately to circulated air. Additional mounting guidelines can be found in the Installation Guide.

END OF SECTION 233400A

SECTION 233400B – HIGH-VOLUME LOW-VELOCITY FANS - HAIKU

1.1 General

A. This section includes information applicable to 42" and 60" fans as scheduled on the Drawings.

1.2 Summary

A. Section Includes

1. The ceiling-mounted circulation fan is the model scheduled with the capacities indicated. The fan shall be furnished with mounting hardware and a remote control as manufactured by Big Ass Fans or approved equal.

2. Summary of Work

a. Installation of the fan, miscellaneous or structural metal work (if required), field electrical wiring, cable, conduit, fuses and disconnect switches, other than those addressed in the installation scope of work, shall be provided by others. Installation services are available through Big Ass Fans or approved equal. Consult the appropriate installation scope of work for information on the available installation options, overview of customer and installer responsibilities, and details on installation site requirements.

B. Related Sections

1. 21 00 00 Fire Suppression
2. 23 00 00 Heating, Ventilating, and Air Conditioning (HVAC)
3. 26 00 00 Electrical

C. References

1. Canadian Standards Association (CSA)
2. Electromagnetic Compatibility (EMC)
3. Federal Communications Commission (FCC)
4. International Electrotechnical Commission (IEC)
5. International Organization for Standardization (ISO)
6. Low Voltage Directive (LVD)
7. National Electric Code (NEC)
8. National Fire Protection Agency (NFPA)
9. Norma Official Mexicana (NOM)
10. Restriction of Hazardous Substances (RoHS)
11. Underwriters Laboratory (UL)

D. Submittals

1. Shop Drawings: Drawings detailing product dimensions, weight, and attachment methods
2. Part 2 Product Data: Specification sheets on the ceiling-mounted fan, specifying

electrical and installation requirements, features and benefits, and controller information

3. Revit Files: Files provided for architectural design, as applicable
4. Part 2 Product Documentation: The manufacturer shall furnish a copy of all installation, operation, and maintenance instructions for the fan.
5. Schedule

E. Quality assurance

1. Certifications
   a. Safety
      i. The fan assembly, as a system, shall be ETL-certified and built pursuant to the following standards.
      ii. United States
         a) CFR, Title 47, Chapter I, Part 15 Subpart B. Radio Frequency Devices – Unintentional Radiators.
         b) UL 507. Standard for Safety for Electric Fans.
      iii. The fan motor shall be ETL-certified and built pursuant to the following standards.
         a) United States
            (a) UL 1004-1. Standard for Safety for Rotating Electrical Machines – Part 1 General Requirements.
            (b) UL 1004-2. Standard for Safety for Impedance Protected Motors
   b. Sustainability Certification
      i. Forest Stewardship Council (FSC) certification
      ii. ENERGY STAR® certification – ENERGY STAR Most Efficient 2015
   c. Manufacturer Qualifications
      i. The fan and any accessories shall be supplied by Big Ass Fans or approved equal that has a minimum of ten (10) years of product experience.
      ii. ISO 9001:2008-certified

F. Delivery, storage, and handling

1. Deliver product in original, undamaged packaging with identification labels intact. The fan shall be new, free from defects, and factory tested.
2. The fan and its components must be stored in a safe, dry location until installation.

G. Warranty

1. The manufacturer shall replace any products or components defective in material

or workmanship, free of charge to the customer (including transportation charges within the USA, F.O.B. Lexington, KY), pursuant to the complete terms and conditions of the Big Ass Fans or the approved manufacturer's Non-Prorated Warranty in accordance to the following schedule:

Item	Period of Coverage
Motor	2 years
All other components	1 year

Labor to repair the defect will be provided free of charge at the Big Ass Fans service center or service center of approved manufacturer for defects arising during the Warranty Period.

1.3 Product

A. Manufacturer

1. Delta T Corporation, dba Big Ass Fans, PO Box 11307, Lexington, Kentucky 40575.
Phone (877) 244-3267. Fax (859) 233-0139. Website: www.bigassfans.com.

2. Approved equivalent, as determined by the Engineer/Architect.

B. Big Ass Fans' Haiku (or approved fan model complying with Specifications)

1. Complete Unit

a. Regulatory Requirements: The fan assembly, as a system, shall be ETL-certified and built pursuant to relevant safety standards as described above.

b. Sustainability Characteristics: The fan shall possess the ENERGY STAR Most Efficient 2015 designation. The bamboo fan assembly, as a system, shall be built pursuant to environmental and sustainability standards of the Forest Stewardship Council.

c. Quality: The fan shall display good workmanship in all aspects of its construction. Field balancing of the airfoils shall not be necessary.

d. Colors and materials: Airfoil materials and colors may be selected by architect or owner as described in 2.2.C, "Airfoils."

e. Optional accessories: A wall-mounted controller (in addition to the standard remote control) and an LED light kit may be selected at the time of order.

2. Mounting System

a. Low profile

i. The low profile model shall be suitable for flat ceilings as low as 8 ft (2.4 m) tall.

ii. The fan shall be equipped with a mounting plate, rubber bumpers, a mounting bracket, a compact, low-profile motor hub assembly, and mounting hardware.

iii. The low profile fan shall be available with either a diameter of 52" (1.3 m) or 60" (1.5 m).

b. Standard profile

i. The standard profile model shall be suitable for flat ceilings with heights ranging from 8.5–12 ft (2.6–3.7 m).

ii. The fan shall be equipped with a rubber bushing, mounting bracket, wiring cover, wiring cover trim, standard motor hub assembly, and mounting hardware.

iii. The standard profile fan shall be available with either a diameter of 52" (1.3 m) or 60" (1.5 m).

c. Extended profile

i. The extended profile model shall be suitable for flat or sloped ceilings with heights ranging from 8.5–18 ft (2.6–5.5 m).

ii. The fan shall be equipped with a mounting bracket, canopy, mounting ball and wedge, extension tubes, wiring cover, motor hub, and mounting hardware.

iii. Both a 7-inch and a 20-inch extension tube shall be included with the fan.

iv. The extended profile fan shall be available with either a diameter of 52" (1.3 m) or 60" (1.5 m).

3. Airfoils

a. The fan shall be equipped with three airfoils spanning a total diameter of either 60" (1.5 m) or 52" (1.3 m), as specified by the architect or owner.

b. Airfoils shall be available in the following materials.

i. Bamboo

a) Bamboo airfoils shall be available in Caramel (light brown) or Cocoa (dark brown) as specified by the architect or owner.

b) Bamboo airfoils shall be suitable for indoor spaces only.

ii. Matrix Composite

a) Composite airfoils shall be available in an automotive-grade black or white finish as specified by the architect or owner.

b) Composite airfoils shall be damp-rated for use in covered outdoor spaces.

4. Motor

a. The fan shall have an electronically commutated motor (ECM) rated for 100–240 VAC, single-phase.

b. The motor shall draw 4–30 watts depending on the speed at which the fan is operated and if a light is installed.

c. The fan shall be designed for continuous operation in ambient temperatures of 32 to 104°F (0 to 40°C), and a humidity range of 20–90% (non-condensing).

d. The fan's motor unit trim (lower cover) shall be available in black or white as specified by the architect or owner.

5. Remote Control

a. The fan shall be equipped with a compact remote control that allows intuitive operation of the fan in the following modes:

i. Speeds 0 (off) through 7 (high) for standard and extended profile fans; for low profile fans, speeds 0 (off) through 6 (high).

ii. Sleep mode: Sleep mode shall reduce the fan speed by one increment every hour until the lowest speed is reached. When the programmed time period ends, the fan automatically turns off. Sleep mode is only active when Timer mode is used.

iii. Timer mode: In Timer mode, the fan runs at a set speed until the programmed time period ends.

iv. Whoosh® mode: Whoosh mode simulates natural, relaxing breezes by automatically varying the fan speed in a quasi-sinusoidal pattern.

b. The remote included with the (optional) light accessory shall control both the fan and the light. Brightness shall be increased or decreased by pressing the Up or Down Light button on the remote, and the light shall be turned on or off by pressing the Light On/Off button.

c. Each operating mode shall be indicated by a pattern on the fan mode indicator display, which shall be located on the bottom of the fan and shall be visible from the floor. All indicators shall automatically turn off approximately five seconds after the last control button is pressed.

d. The remote shall be 1.2″ wide × 3.4″ tall × 0.2″ thick, and shall operate on a CR 2025 3V lithium battery (included).

6. Safety Cable

a. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be 1.5 mm in diameter and fabricated of aircraft steel.

b. Field construction of safety cables is not permitted.

7. Wall Controller (Optional)

a. The fan shall be equipped with a wireless wall controller in addition to the standard remote control, as specified by the architect or owner.

b. The wall controller shall feature the same controls and functions as the remote control, including fan speed, Sleep mode, Timer mode, and Whoosh mode.

c. The wall controller shall also control the fan light (on/off and variable brightness) if applicable.

8. LED Light (Optional—Refer to Schedule)

a. The fan shall be equipped with an LED light, as specified by the architect or owner.

b. The light kit shall include an LED cover ring (for composite fans) or an LED mounting bracket (for bamboo fans), an LED light module, a white and a black lens cover, and mounting hardware.

c. The white lens cover shall be installed for maximum light emission. The black lens cover shall be installed for dimmer light emission.

1.4 Execution

A. Preparation

1. The fan location must have an appropriate ceiling-mounted outlet box marked, "Acceptable for Fan Support." If there is not an appropriate outlet box already installed at the location, one must be installed on a ceiling joist or beam and be properly wired. At least 8" (20.3 cm) of wires should be hanging from the outlet box. Additional mounting options may be available. Consult the installation guide for additional details.

2. The fan location must be free from obstacles such as lights, cables, or other building components.

3. Check the fan location for proper electrical requirements. Consult the installation guide for appropriate circuit requirements.

B. Installation

1. Install the fan according to the manufacturer's installation guide, which includes acceptable mounting methods.

2. Minimum Distances

a. Airfoils must be at least 7 ft (2.1 m) above the floor.

b. The airfoils must have at least 2 ft (0.6 m) clearance from all obstructions.

3. The fan shall not be located where it will be continuously subjected to wind gusts or in close proximity to the outputs of HVAC systems or radiant heaters. Consult the installation guide for additional details.

END OF SECTION 233400B

SECTION 233521 - SLIDING BALANCER TRACK VEHICLE EXHAUST REMOVAL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Conditions of the Contract and portions of Division One of this Project Manual apply to this Section as though repeated herein.

1.2 SUMMARY

A. Provide all labor, materials, and equipment necessary to put in working operation a complete turnkey system to remove both diesel and automotive exhaust gases and particulate of operating vehicles within the confines of specified fire station(s). All necessary controls, motors, fittings, ductwork, blower(s), labor and all other equipment and materials specified shall be part of the work.

B. Section Includes:

1. Manufacturer
2. Sliding Track.
3. Support Legs.
4. Double Track Joiner Plate.
5. Track Splicing Assembly.
6. Riser Clamp Assembly.
7. Trolley/Balancer Assembly.
8. Upper Flexible Hose
9. Lower Hose Assembly
10. Safety Disconnect Coupling.
11. Collection Nozzle Assembly..
12. Hose Saddle.
13. Electrical Controllers.
14. Electrical System.
15. Air Moving Devices.
16. Ductwork System.

C. All items of equipment and materials described in these specifications are to be furnished installed and placed into proper operating condition in accordance with good practice and manufacturer's written or published instructions.

1. The exhaust removal system shall provide virtually 100 percent complete evacuation of all diesel fumes at the source from start up to exit of the apparatus from the fire station. The diesel exhaust removal system shall be capable of delivering complete coverage for bays up to 60 feet (18.3M) in length. The system must be able to accommodate drive through and back-in bays to meet all the needs of the fire department.

2. System must be designed and installed to NIOSH recommendation, specifying that occupational exposures to carcinogens be limited to the lowest feasible concentration. Exposure in the human breathing zone should be limited to lowest feasible level, without any time delay required for the system to effectively capture the diesel fumes.

3. System must also be capable to provide virtually complete capture and evacuation of carbon monoxide emitted as part of the vehicle exhaust.

4. Systems that solely use filters, in which diesel particulate may accumulate, and that would potentially have to be treated as hazardous materials, will not be accepted.

5. System must meet the guidelines for the International Mechanical code for Source Capture Systems. Such system is defined as a mechanical exhaust system designed and constructed to capture air contaminants at their source and to exhaust such contaminants to the outdoor atmosphere.

6. The system shall not affect personnel boarding the apparatus. Hose loops shall not hang any lower than six feet from the bay floor. The hose assembly shall not come into contact with the vehicle other than one connection point to the vehicle's tailpipe. The hose assembly shall not touch or drag on the bay floor.

7. The exhaust system shall not block doorways, exits, and aisles in the apparatus bay, which could endanger the welfare of fire personnel or visitors.

8. The exhaust system shall not need to be disconnected from the vehicle while shore lines are connected, during battery charging, or washing of the vehicle.

9. To protect the apparatus electrical system from possible damage, the system bid shall not incorporate any type of electromagnetic device that requires the apparatus to be utilized as an electrical ground for systems operation.

10. When reviewing requests for substitutions, no exception to the following requirements shall be allowed.

    a. Due to the harmful effects of diesel exhaust, the system must be designed and capable of capturing virtually 100% of the exhaust gas and virtually 100% of the particulate even in the event of a complete power failure. The system shall not detach itself from the apparatus for any reason during a power failure other than normal exiting of the apparatus bay. System shall discharge exhaust outside the station even in the event of a power failure.

    b. The system shall capture the exhaust gases and particulate directly from the tailpipe of the apparatus by a direct connected "visible" high temperature rated hose. Particulates emitted from the apparatus are known to be heavier than air and therefore must be captured by a directly connected hose with a tight seal, as loose nozzles or air filters cannot capture these heavy particulates. The particulates have been documented to be the main respirable carcinogen in diesel exhaust, and therefore are the primary concern of the fire department to capture virtually 100% of these particulates.

1.3 SUBMITTALS

A. Product Data: Indicate manufacturer's model number, technical data including description of components and static pressure/air flow chart, and installation instructions.

1. Details of wiring for power differentiating between manufacturer-installed and field-installed wiring.

B. Closeout Submittals: Operation and Maintenance data manual including spare parts list, and warranty.

1.4 QUALITY ASSURANCE

A. Engage a factory certified installer to perform work of this Section who has completed installations similar in design and extent to that indicated for this Project, and who has a record of successful in-service performance. No Exceptions.

B. The manufacturer must be a ISO 9001:2000 certified www.iso.org manufacturer with certification issued to a United States facility. Manufacturer shall be UL and CUL Certified www.ul.com/database/ and certified by the Air Movement and Control Association (AMCA) www.amca.org/search.htm to ensure quality, consistency and reliability of products. All certification documents shall be provided and attached to the bid proposal. No exceptions.

C. Engage a firm experienced in manufacturing vehicle exhaust systems similar to that indicated for this Project and with a record of successful in-service performance.

D. Conduct conference at Project site. Review methods and procedures related to vehicle exhaust system installation.

1. Review access requirements for equipment delivery.
2. Review equipment storage and security requirements.
3. Inspect condition of preparatory work performed by other trades.
4. Review structural loading limitations.
5. Review that all components specified in this Section and related components specified in other Sections are accounted for.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading: Deliver components with protective packaging. Store in original protective crating and covering and in a dry location.

1.6 PROJECT/SITE CONDITIONS

A. Existing Conditions: Verify dimensions of installation areas by field measurements.

1.7 COORDINATION

A. Coordinate layout and installation with other work, including light fixtures, fixed equipment and work stations, HVAC equipment, and fire-suppression system components.

B. Coordinate location and requirements of service-utility connections.

1.8 REFERENCES

A. Air Movement & Control Association International, Inc.

1. AMCA Standard 500-D-98, "Laboratory Methods of Testing Dampers for Rating".

B. ASTM International.

1. Stainless Steel:

a. A240/A240M-04ae1 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

b. Bright, Directional Polish: No. 4 finish.

2. Aluminum:

a. B209/209M-04 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

b. Powder-Coated Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

3. Galvanized Steel:

a. A653/A653M-04a Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

1.9 BIDDER QUALIFICATIONS

A. Bids will only be accepted from companies that have an established reputation in the business of system design, turnkey installation and long-term service of Automatic Emergency Response Vehicle Exhaust Removal Systems for a minimum of no less than five (5) years. Bidder shall be a registered corporation, partnership or sole proprietorship within the State where the installation is to take place. Bidder must have a current and valid state contractor's license, if required by the state for the work that is being bid. Bidder shall show proof that the system specified in this Bid Document has been field tested and proven by supplying a list of references with no less than 10 fire stations with systems installed by bidder (with comparable emergency and non-emergency run rates) within a 200 mile radius of municipality seeking bid. References shall be submitted with the Bid Document and shall include phone numbers and contact names.

1.10 MANUFACTURER QUALIFICATIONS

A. Bids shall only be accepted by bidders supplying equipment from manufacturers that have an established reputation in the business of manufacturing Automatic Emergency Response Vehicle Exhaust Removal Systems for a minimum of no less than ten (10) years. The manufacturer must be a ISO 9001:2000 Certified in the United States www.iso.org, UL and CUL Certified www.ul.com/database/ and certified by the Air Movement and Control Association (AMCA) www.amca.org/search.htm to ensure quality, consistency and reliability of products. Certification documents shall be provided and attached to the bid proposal. No exceptions. Where the requirement calls for a packaged exhaust system to be provided, all items shall be the product of the manufacturer. The product offering must be a product that has been offered by that manufacturer for a minimum period of five (5) years. No prototypes or private label products by other manufacturers will be allowed. System bid shall have a life of service

of no less than 10 years to establish proof of quality, longevity and service. No exceptions.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. PlymoVent Corporation/Plymovent Industrial Ventilation Systems (Basis of Design)
115 Melrich Road
Cranbury, New Jersey 08512
USA
Telephone: (609) 395-3500
Toll Free: (800) 644-0911
FAX: (609) 655-0569
WEB: info@plymoventusa.com

B. AirVac 911® Engine Exhaust Removal Systems

C. Ward Diesel Filter (No Smoke)

2.2 SLIDING TRACK

A. A one-piece continuous extruded aluminum track in a minimum length of 19 feet (5791.2 mm). Profile shall be of a Boxloc type profile, track height 3-1/8 inches (73.4 mm), track width 1-½ inches (38.1 mm), track thickness 1/8 inch (3.175 mm); aircraft aluminum alloy Type AA-6063 (ASTM B209/B209M). Track: Extruded design that shall incorporate three separate and functioning channels. Channels: Includes the mounting channel, the trolley channel and the Boxloc channel. Mounting Compartment: Designed to accept the slider bars (which shall be provided with factory supplied vertical support legs and riser clamp duct connection) and to allow positioning along the full length of the slotted track-mounting channel. Mounting Channel: Also accommodate the compressed airlines for the purposes of safe storage and appearance. Trolley Channel: Allow the trolley/balancer/ hose assembly to glide to the door threshold in a safe and effective manner. Boxloc Channel: Allow the whole track to remain rigid as it hangs from factory supplied leg supports and also shall provide an area to attach bolts for splicing additional tracks together for systems over 19 feet (5791.2 mm) long. The overall extruded track lengths shall be 19 foot standard and shall weigh no more than 35 pounds (15.88 KG). The track system shall be equipped with end stops that limit travel of flex hose as the vehicle exits the building. The end stop shall be fabricated of zinc plated steel in a U shape form with a rubber end stop on the impact end. It shall be attached by using a ¼ inch (6.35 mm) molded locking bolt. The end stop shall be secured to the track with no less than (2) ¼ inch (6.35 mm) bolts and locking nuts located on the underside of the track. For security, a ¼ inch 6.35 mm) bolt shall be drilled through the ends of each track system to ensure that the trolley/balancer assembly(s) roll no further than the end of the track system.

2.3 SUPPORT LEGS

A. Support Leg and Mounting Feet: Manufactured and provided by the supplier of primary exhaust removal system (Equipment Manufacturer). Leg Material: Aircraft aluminum alloy Type AA-6063 (ASTM B209/B209M). Supports shall come standard in 19 feet

(5791.2 mm) lengths. A minimum of one support with appropriate bracing shall be provided for every 10 linear feet (3048 mm) of track profile. The support legs shall consist of a square tubular profile with dimensions no less than 2 inch (50.8 mm) OD X 0.1 inch (2.54 mm) with 0.4 inch (10mm) fastening hardware provided. Vertical Adjustable Mounting Foot: Capable of attaching the leg assembly to a ceiling with a 30 degree pitch, complete with a slider bar and 3/8 inch (9.5 mm) hardware necessary for mounting the horizontal track to the mounting channel system. Horizontal Adjustable Mounting Foot: Capable of attaching the leg assembly to a wall, complete with a slider bar and 3/8 inch (9.5 mm) hardware necessary for mounting the horizontal track to the mounting channel system. Support Leg: Equipped with round tubular zinc-plated steel knee brace with pressed ends in standard lengths of 20 inches (508 mm), 30 inches (762 mm) and 72 inches (1828.8 mm). Angle Completely adjustable to the leg support and mounted perpendicular and parallel to direction of the track. Typical Support Angle: 45 degrees from the centerline of the factory provided support leg. The standard leg shall be capable of meeting a Seismic 4 requirement. "Uni-strut", all-thread rod, and/or chains may not be used in place of a leg assembly or to support the system.

2.4 DOUBLE TRACK JOINER PLATE

A. Joiner Plate: constructed from a minimum of ¼ inch (6.35 mm) thick zinc-plated material, designed to connect two parallel tracks to make a double track system to accommodate an apparatus bay over 40 feet (12192 mm) in length. Joiner Plate: 10 inch (254 mm) by 8 inch (203.2 mm) flat zinc-plated steel and designed to attach the two tracks to a single factory supplied support leg. The steel plate shall have (6) 3/8 inch (9.5 mm) holes drilled 6-7/8 inches (174.6 mm) apart to accommodate the slider bar provided with factory support legs. Joiner Plate: Have two slider bars attached to the plate, located on the outside edges of the plate. These slider bars shall fit into the Boxloc track mounting channel for a simple and secure attachment of the plate to the Boxloc track. The center portion of the joiner plate shall provide attachment for the factory supplied support leg.

2.5 TRACK SPLICING ASSEMBLY

A. Track Splice: Manufactured of galvanized steel (ASTM A653/A653M) in two parts and utilized as a clamping device. This clamp shall accurately secure both tracks together in a fashion, which shall eliminate any possibility of obstructing the trolley assembly as it passes through this connection point of track system. Connecting length of splice shall be a minimum of 15-3/4 inches(400 mm) long and fabricated of 14 gauge material. Four (4) 1/4 inch (6.35 mm) bolts with lock nuts shall pass directly through internal partition of the Boxloc track. The splicing sleeve shall fit externally around the outside dimension of extruded aluminum track profile.

2.6 RISER CLAMP ASSEMBLY

A. Riser Clamp: Fabricated as a one piece welded assembly, manufactured to create the transfer of the hard spiral pipe joined at the top and flexible duct connection at the bottom. A slider bar and associated hardware shall be provided with riser clamp assembly. Sizes of the riser clamp will range from 4 inches (101.6 mm) to 5 inches (127 mm) in diameter to match the output velocity of the vehicles that will park in that station.

2.7 TROLLEY/BALANCER ASSEMBLY

A. Trolley Assembly: Manufactured as a two piece galvanized steel assembly including bumper stops at each end. Fixed to the side of the trolley are solid steel pins, which shall be for load carrying bearings that are sealed and permanently lubricated. The load

carrying bearings shall travel internally in track trolley channel. Two additional permanently lubricated trolley wheels shall be provided on bottom side of the track to reduce wobble of trolley as it conveys the hose assembly to the door threshold. Release Plate: Attached to the chassis of the trolley to smoothly energize the uncoupling release valve when the trolley-balancer assembly approaches the door threshold. System Balancer Assembly: Self-adjusting weight spring tension balancer with a lifting capacity of no less than 31 pounds (14 KG). The balancer shall have a minimum diameter stainless steel cable of .080 inch (2 mm), with a safety link connection.

2.8 UPPER FLEXIBLE HOSE

A. Upper Hose: Flexible exhaust hose manufactured for the sole purpose of venting high temperature exhaust gases. Flexible Hose: Designed strictly for the harsh environment of rapid response and auto-release of a vehicle exhaust tailpipe. Hose: Range from 4 inch (101.6 mm) to 5 inch (127 mm) diameters with varying lengths depending on the system length required ranging from 20 feet 6096 mm) to 43 feet (13106 mm) without joining or splicing connections. Hose Material: High temperature synthetic rubber impregnated into a high temperature laminated fabric with a minimum overlapping thickness of 2-7/16 inches (61.9 mm). This construction of hose must be capable of operating at continuous temperatures of 400 degrees F (204 degrees C) and intermittent temperatures of 500 degrees F (260 degrees C) such as are experienced when pump checks are performed inside the station. Wire Helix: Bound and protected in laminations of hose winding. This shall be accomplished in a fashion, which eliminates any possibility of personnel coming in contact with an exposed hot metal helix. The hose shall further protect the internal wire helix from heat buildup and in turn add increased visibility to personnel. Wear Strip: 9/16 inch (14.28 mm) wide and be provided as a safety yellow color. The bend radius of the high temperature hose shall be no less than 1.5 times the diameter of hose to ensure that hot gases are not restricted as they pass through the system. Hoses utilizing an exposed metal helix will not be acceptable due to potential burn hazard and/or shock hazard from being utilized as a grounded, grounding or current carrying conductor for electromagnet connections. No exceptions will be allowed.

2.9 LOWER HOSE ASSEMBLY

A. Lower Hose: Rigid 4 inch (101.6 mm) to 5 inch (127 mm) diameter by 2 foot (609.6 mm) long section of yellow and black hose identical in appearance to the upper hose assembly. Lower Hose: Support the connection nozzle and Stainless reducing elbow in a rigid fashion to allow for the operator to place hose collection nozzle onto the tailpipe without bending over. The lower hose is the only section of hose which shall disconnect from the upper hose assembly and act as a safety disconnect in the unlikely event the nozzle gets entangled. Hoses utilizing an exposed metal helix will not be acceptable due to potential burn hazard.

2.10 SAFETY DISCONNECT COUPLING

A. Safety Disconnect Coupling: 4-part segmented coupling with removable wear strips to protect the vehicle and disconnect from wear shall be incorporated in the design of the system. Coupling: Consists of two high temperature composite collars connected by a reusable-segmented coupling band. The release tension of this device shall be preset at 130 pounds (59 KG). and adjustable from 20 pounds (9 KG). to 206 pounds (93 KG). of separating force to accommodate varying exit speeds of vehicles. Coupling shall be re-usable and easily reconnected.

2.11 COLLECTION NOZZLE ASSEMBLY

A. Collection Nozzle Assembly: Provides a substantially air tight seal around exhaust tail pipe when connected thus allowing for virtually 100% source capture. The seal shall limit escape of life threatening exhaust gases, which may be present during the following conditions:

1. In the event vehicle's engine is accelerated above normal idle resulting in an exhaust velocity greater than 5000 feet per minute (25.4 meters per second).

2. In the event that the output velocity or CFM of the exhaust exceeds the manufacturers normal capture velocity or CFM of exhaust system.

B. Magnetic Nozzle: Engineered and specially designed Patent Pending exhaust system nozzle (female connection) that is specifically designed to fit tightly over the circumference of an engineered conical mating ring (male connection) that attaches to the tail pipe and attaches tightly around the ring to capture virtually 100% of the carcinogenic diesel exhaust

C. The Stainless-reducing elbow that connects to the connection nozzle shall be fabricated using continuous welded construction. Angle of Transition: No less than or greater than 67 degrees from the centerline of the reducer. stainless Reducer: Incorporate a primary expanded metal debris screen, which is permanently affixed by welded seams to the inside, opening of exhaust fitting.

2.12 HOSE SADDLE

A. Hose Suspension Saddle: Fabricated of a rubber molded cushion specifically manufactured for the sole purpose of suspending high temperature exhaust ventilation hose in a rapid response and auto-release application. The design of the saddle shall smoothly transition the direction of the hose during its travel along the track. Securing clamps shall be provided including a link fastener, for the purpose of mounting it to the balancer safety link.

2.13 ELECTRICAL CONTROLLERS

A. Controller: Built and supplied by a UL recognized and listed exhaust system manufacturer. Controller shall carry the UL - CUL listing label as an "Enclosed Industrial Control Panel." Individual components listed by UL - CUL shall not satisfy the above requirement. Manufacturer shall undergo monthly inspections by UL to verify all requirements and standards are met as outlined by UL. The controller shall be delivered as an Operating System Three series controller or an approved equal to the specifications to follow.

B. Electrical Controllers: Bear a visible UL listing label as proof of subscribership and shall be validated by UL www.ul.com/database/ as an "Enclosed Industrial Control Panel". Certification documents shall accompany bid documents.

1. Manufacturer Name:

2. UL File No.:

3. Electrical controller and manufacturer shall be recognized and listed by UL. Controller shall be manufactured in accordance with Underwriters Laboratories standard UL-508 for "Enclosed Industrial Control Panels". The electrical controller shall include a Class 1 limited energy control circuit. Enclosures shall be NEMA 12 rated and UL listed as Type 12. The electrical control components

shall be provided and mounted in an electrical enclosure to restrict access to internal components of the controller by authorized personnel only.

C. Controller Performance: Designed to sense the output pressure and/or temperature change inside the ductwork system, which is normally generated by any internal combustion engine designed to propel a motor vehicle. The operating logic shall be designed to complete this cycle. At any point in time when a collection device is connected to a motor vehicle's exhaust tailpipe, as the operator starts the vehicle, the controller shall automatically sense the engine's output pressure or temperature of the exhaust and in turn energize the electrical contractor which will supply power to the AMCA certified spark resistant fan motor. Through the use of an adjustable timer the controller shall keep the contactors energized for up to six minutes in accordance with the stations response requirement. If the responding vehicle does not disconnect from the exhaust ventilation system in less than the designated setting, the temperature override switch shall override the time delay to ensure continuous system operation. This automated function will work for as long as the exhaust gas temperature is in excess of the setting on the heat sensor located in the ductwork system. This cycle shall not allow the electrical contactor, which energizes the exhaust fan, to short cycle or stop the fan while the system is connected to an operating vehicle.

D. Motor Control Contactor: Allen Bradley Industrial Electrical Contactor 100C series. The contactor shall be UL - CUL listed as an approved component.

E. Motor Control Overload Relay: Allen Bradley 193 E1 Plus series. Overload relay shall have an adjustable trip range to meet the proper full load amperage of the blower motor.

F. Soft Touch Controls: Incorporated on the face or the access door of the controller by the use of an adhesive backed Lexan membrane type label to prevent water infiltration, which would void the NEMA 12R rating. Label: Provided and secured permanently to the exterior of the electrical controller. Label: Include the name of the manufacturer, address, telephone number, user instructions and any warnings or cautions required by Underwriters Laboratories.

1. Auto Start: This mode of operation shall be strictly for normal day to day use, as it would apply to receiving an emergency call and leaving the station. Any one or combination of the three devices listed below in Paragraph H shall activate the system. The system shall maintain itself in the Auto Start mode and always return there after the Stop sequence has been initiated. The controller shall not have a permanent off position due to the potential health hazards of diesel exhaust components.

2. Stop: This mode of operation shall be a system override to shut down the system manually. Upon activating this mode of operation the exhaust system blower shall shut down. After a period not to exceed three seconds the controller shall automatically return to the Auto Start ready mode. This shall be a safety feature to prevent a potential health hazard from carcinogenic diesel exhaust leakage from systems having an undesirable open nozzle.

3. Manual Run: This mode of operation shall be a system override to run the exhaust system blower continuously for the purpose of running the vehicles indoors for equipment checks during inclement weather. Upon activating this mode of operation the exhaust system blower shall start and run continuously until the Stop mode is activated at which point the system will automatically return to the Auto Start ready mode within a maximum three second time period.

G. System Indicator LED's: Show system status at all times.

1. Auto Start Indicator: Indicate the system is in the fully automatic mode of operation and that power is on to the controller.

2. Fan On Indicator: Indicate that power is being applied to the system blower and the controller is operating normally.

3. Filter Status Indicator: Indicates, if flashing, excessive pressure loss across the filter bank media. Consequently the filter must be serviced to maintain optimum efficiency of the system.

4. Stop Indicator: Indicate the fan has been manually de-energized and will return to the Auto Start ready sequence in less than three seconds to prevent the system blower from being left in the Off mode.

5. Manual Run Indicator: Indicate the fan is operating in a continuous run mode until interrupted by the stop mode activation.

H. Controller Transformer: UL listed industrial control circuit transformer sized to properly supply all components so that only one transformer shall be required. Transformer shall be provided with multi-tap primary for 115, 208, 240, 277, 400, 480, and 600VAC, and 24, 120, 230VAC secondary operating on 50 or 60 hertz with a capacity of 90 volt amperes.

I. Control Circuit Protection: By the use of primary and secondary fuses to meet UL requirements. The primary shall be protected by a pair of FLQ style fuses rated at 1.6 amps for voltages under 400V and a pair of .75 amp fuses for voltages over 400V. A single glass fuse rated at 3.15 amps at 250V shall protect the secondary side of the control circuit.

J. Electronic Control Circuit Card: Solid state printed circuit board. The soft controls shall be an integral part of the control circuit card. The control circuit card shall utilize a potentiometer to adjust the length of the timing cycle from 7 to 360 seconds. It shall incorporate several different modes of operation and optional features.

K. Activation Devices:

1. Engine Start Switch: An engine pressure sensing type, capable of recognizing the output pressure of any type of motor vehicle exhaust. The electrical contact shall be dry type or not to exceed 24V ac. There shall be one sensor per vehicle.

2. Thermal Start Switch: Temperature sensing switch of the snap disc type and adjustable from 90 degrees F (32 degrees C) to 130 degrees F (55 degrees C) to configure the system based on different exhaust temperatures. There shall be one sensor per vehicle.

3. Wireless Transmitter and Receiver System: Shall be an optional feature operating on a 900 Mhz spread spectrum frequency and FCC part 15 compliant. The receiver shall utilize 4 independent programmable channels of control and capable of supporting up to 16 transmitters. The receiver shall operate on 24 VAC and enclosed in a non metallic enclosure with a clear see through lid to view digital display for system supervisory functions. The transmitter shall be programmable and shall be powered by a 5 year 3 volt battery for ease of replacement and cost savings. The transmitter shall have an open field range of 2500 feet and shall be initiated by a NO contact closure such as from a pressure switch mounted on the exhaust system or a relay mounted on the vehicle.

L. Clean Filter Indicator Alarm: Used in conjunction with the optional Unifilter for filtering diesel exhaust particulate before release to the atmosphere. The clean filter indicator shall monitor the pressure loss across the filter bank media. Once the useful life of the filter has been depleted the pressure differential switch will signal a high-pressure loss and flash the "Fan On" indicator while the exhaust blower is running.

M. Optional System Monitor: Shall be an optional feature to monitor the system and advise when a preset number of emergency runs or run time on the system have accrued.

N. Optional No Airflow Alarm: Shall be an optional feature to monitor the system and advise when the exhaust fan is not functioning properly.

O. Optional Carbon Monoxide Alarm: Shall be an optional feature to monitor the carbon monoxide levels inside the apparatus bay area.

P. Electrical Wiring: Run in wire channel to allow for easier identification of the wiring circuits and for a neat appearance. All wiring circuitry shall meet National Electric Code and UL standards for proper size, bending radiuses (NEC code ref. 300-34) and terminations.

Q. Electrical Terminal Block: 600 V, UL rated and recognized. It shall provide individual connection points for remote controls, clean filter indicator and power connections. The primary and secondary control wiring fuses shall be incorporated into the terminal block as one unit.

R. Product Manual: Shall be provided with each electrical control box supplied. The product manual shall include a description of components with part numbers inclusive to the controller. It shall include a wiring schematic showing all internal circuitry as well as all field installed wiring connections to the controller.

S. Electrical Interference: To protect the apparatus and communications, designs that allow any possibility of electrical back-feed or induced current which may interfere with a central services communication or onboard vehicle computer logic or navigational equipment will not be accepted.

2.14 ELECTRICAL SYSTEM

A. Station Electric Supply Panel: The power circuit for the "Emergency Response Vehicle Exhaust Removal System" shall originate in a circuit breaker panel board of the appropriate size to handle the load. Fan circuit shall be supplied by a UL listed, HACR rated circuit breaker (HACR rating is specifically for motor type loads) of the same type as indicated by the manufacturer of the circuit breaker panel or a dual element time delay fuse for fuse style panels. The circuit shall be clearly marked on an engraved ledger plate or in ink on the panel schedule as "Emergency Response Vehicle Exhaust Removal System".

B. OS-3 Automatic Controller: Built and supplied by a UL recognized and listed exhaust system manufacturer. Controller shall carry the UL - CUL listing label as an "Enclosed Industrial Control Panel". Individual components listed by UL shall not satisfy the above requirement. Manufacturer must undergo monthly inspections by UL to verify all requirements and standards are met as outlined by UL. The controller shall be delivered as an Operating System Three series controller or an approved equal to the specifications in 2.17 Electrical Controllers. The controller shall be mounted 6 feet (1829 mm)to the top of the cabinet AFF (above finished floor). A safety disconnecting means must be within sight of the controller for servicing and for safety reasons. If the supply panel is not within sight, a separate disconnecting means is required beside the controller (per NEC

Code 2008). Safety disconnect shall be capable of being locked in the off and on position to follow lockout, tag out procedures. See attached Table 1-1 for proper Square D part number of safety disconnect switch.

C. Power Wiring Conduit: Minimum of EMT utilizing fittings for damp locations such as apparatus wash down areas (per NEC Code 2008). Conduit shall be supported with a conduit strap every 10 feet and within 3 feet of each box or termination, (per NEC 2008).

D. Power Wiring from Supply Panel to OS-3: THHN stranded copper wire consisting of a flame retardant, heat-resistant thermoplastic insulation with a nylon jacket for abrasion, gas, and oil resistance and rated up to 600 volts.

E. Low Voltage Control Wiring: Minimum of a 16/2 multi-conductor cable to meet UL standards for the controller's low voltage field wiring.

F. Low Voltage Control: Encased in a minimum of ½ inch (12.7 mm) EMT from the OS-3 Controller to the attic or building steel where it shall terminate with a EMT connector with a threaded plastic bushing. Conduit: Supported with a conduit strap every 10 feet and within 3 feet of each box or termination (per NEC Code 2008). The 16/2 multi-conductor cable shall be supported by the building structure and ran in a manner that the cable will not be damaged by normal building use (per NEC Code 2008), securely fastening it with nylon tie wraps every 24 inches (609.6 mm) to 36 inches (914.4 mm). Draping of the cable perpendicular to building steel or support members will be unacceptable.

G. Power Wiring from OS-3 to Fan Motor: Minimum of EMT utilizing compression type fittings for damp locations such as apparatus wash down areas (per NEC Code 2008). Conduit shall be supported with a conduit strap every 10 feet (3048 mm) and within 3 feet 914.4 mm) of each box or termination (per NEC Code 2008). Conduit shall extend through the outside wall through a hole of the proper size and terminate directly into the back of the safety disconnect with the appropriate connector and sealed with a silicon sealer or cement mortar. (Using fan model number select appropriate wire and conduit size from Table 1-1).

H. Fan Safety Disconnect: Square D, non-fusible, NEMA 3R rated for wet locations, mounted adjacent to the AMCA Certified blower. Safety disconnect shall be capable of being locked in the off and on position to follow lockout, tag out procedures. (Using fan model number select appropriate safety disconnect from attached Table 1-1).

I. Liquid Tight Flexible Metal Conduit: UL listed liquidtight flexible metallic conduit (Sealtite). Conduit will encase the load wires and ground wire from the safety disconnect switch to the blower motor. Conduit length not to exceed 4 feet (1219.2 mm) from disconnect to blower motor. The appropriate listed terminal fittings shall be used (per NEC Code 2008). (Using fan model select appropriate conduit size from attached Table 1-1).

J. Spark Resistant Blower: AMCA certified, designed and installed as a direct drive spark resistant blower (IMC code ref. 503.2) The motor shall meet current EPACT standards for energy savings. Fans utilizing steel impellers will not be accepted.

K. Optional Temperature Switch: One for each apparatus connected to the system. The temperature switch shall be of the snap disc type and adjustable from 90 degrees F (32 degrees C) to 130 degrees F (54 degrees C). It shall be mounted on the ductwork 2 inches (50.8 mm) above the pressure switch by drilling a 1 inch (25.4 mm) hole, sealing the switch with silicon sealant and securing with 2 tek screws. Electrical connection shall be

made with terminals provided or solder less type such as Thomas & Betts part no. 14RB-2577 or equivalent.

L. Pressure Switch: One for each apparatus connected to the system. The pressure switch shall operate at a maximum of 24VAC, pre-calibrated at .18 in. of water column. Mounting shall be accomplished by drilling a 3/8 inch (9.5 mm) hole 3 inches 76.2 mm) above the riser bracket and to the left of the regulator and threading the switch into the duct. The electrical connections shall be made with a 0.020 inch (.5 mm) by 0.187 inch (4.8 mm) female quick disconnect terminals, such as Thomas & Betts part no. 14RBD-18277 or equivalent.

OS-3 Controller Component Sizing Chart

Table 1-1

Single Phase

	Motor	HP	Name Plate		Circuit	Wire Size	Length of Wire in Feet		NEC	
PlymoVent	Manuf.	Rating	Voltage	FLA	Breaker	THHN	Start to Finish		Table	
Model					Size	AWG	From	To	Amps	
No. 67001	Leeson	1hp	115V	12A	20A	#10	0'	115'	16A	
						#8	116'	184'		
			230V	6A	15A	#14	0'	183'	8A	
						#12	184'	290'		
67003	Leeson	3hp	230V	16A	30A	#10	0'	215'	17A	
67005	Leeson	5hp	230V	24A	40A	#8	0'	216'	28A	
67007	Marathon	7.5hp	230V	32A	50A	#8	0'	133'	40A	
						#6	134'	211'		
						#4	212'	336'		
67009	Marathon	10hp	230V	41.5A	60A	#6	0'	167'	50A	
67012						#4	168'	266'		
67013						#3	267'	335'		

Three Phase

67002	Leeson	1hp	208V	3.2A	15A	#14	0'	358'	4.6A	
			230V	3.6A	15A	#14	0'	352'	4.2A	
			460V	1.8A	15A	#14	0'	1409'	2.1A	
67004	Leeson	3hp	208V	8A	15A	#12	0'	181'	10.6A	
			230V	7.4A	15A	#12	0'	223'	9.6A	
			460V	3.7A	15A	#14	0'	563'	4.8A	
67006	Leeson	5hp	208V	12.8A	30A	#10	0'	187'	16.7A	
						#8	188'	298'		
			230V	12A	30A	#10	0'	229'	15.2A	
			460V	6A	15A	#14	0'	362'	7.6A	
67008	Leeson	7.5hp	208V	17.6A	30A	#10	0'	145'	24.2A	
						#8	146'	231'		
						#6	232'	366'		
			230V	16.8A	30A	#10	0'	174'	22A	
						#8	175'	278'		
			460V	8.4A	15A	#14	0'	275'	11A	
						#12	276'	437'		
67010	Leeson	10hp	208V	25.9A	40A	#8	0'	178'	30.8A	
67011						#6	179'	282'		
			230V	23.6A	40A	#8	0'	215'	28A	
						#6	216'	340'		
			460V	11.9A	20A	#12	0'	338'	14A	
67014	Leeson	15hp	208V	38.5A	60A	#6	0'	190'	46.2A	
						#4	191'	303'		
			230V	35A	60A	#6	0'	231'	42A	
						#4	232'	369'		
			460V	17.6A	30A	#10	0'	365'	21A	

PlymoVent assumes no liability for any electric installation, all local, city, and the 2008 National Electric Code must be followed. This chart is a minimum standard and to be used as a guideline only. Based on 3% voltage drop for branch circuits.

OS-3 Controller Component Sizing Chart

Table 1-2

Single Phase

	Motor	HP	Name Plate		Circuit	Wire Size	Length of Wire in Feet		NEC	
PlymoVent	Manuf.	Rating	Voltage	FLA	Breaker	THHN	Start to Finish		Table	
Article					Size	AWG	From	To	Amps	
No.										
3906-A251	WEG	3hp	230	13.5	30A	#10	0'	206'	17A	
3911-A251	WEG	5hp	230	21	30A	#10	0'	132'	28A	
						#8	133'	211'		
3912-A251	WEG	7.5hp	230	32	50A	#8	0'	138'	40A	
						#6	139'	219'		
						#4	220'	350'		

Three Phase

3906-A081	WEG	3hp	208	8.4	15A	#14	0'	136'	10.6A	
			230	7.6	15A	#14	0'	166'	9.6A	
			460	3.8	15A	#14	0'	667'	4.8A	
3911-A081	WEG	5hp	208	13	30A	#10	0'	223'	16.7A	
			230	11.8	20A	#12	0'	170'	15.2A	
						#10	171'	272'		
			460	5.9	15A	#14	0'	430'	7.6A	
3912-A081	WEG	7.5hp	208	19.2	30A	#10	0'	151'	24.2A	
						#8	152'	241'		

			230	17.3	30A	#10	0'	185'	22A	
						#8	186'	295'		
			460	8.66	15A	#14	0'	293'	11A	

2.15 AIR MOVING DEVICES

A. Centrifugal Fans: Direct drive centrifugal type, high pressure, single width, single inlet as required or indicated. Impeller Wheels: Radial design or backward incline for performance, spark resistant and made of a non ferrous material to prevent static electricity build up. The impeller shall be dynamically and statically balanced and of the non-overloading type to provide maximum efficiency while achieving quiet, vibration-free operation. The fan housing shall be manufactured from a epoxy powder coated galvanized steel or nonferrous material. The outlet configuration shall be top horizontal, bottom horizontal, or upblast. The housing shall be capable of field reconfiguration in the event the mounting position needs to be changed for unforeseen reasons. For aesthetic reasons the fan motor and assembly shall be mounted on a welded Type 304 stainless steel (ASTM A240/A240M) or epoxy powder coated steel mounting base to prevent rust stains on the exterior of the building. The fan housing and motor mounting hardware shall be Type 304 stainless steel (ASTM A240/A240M) for serviceability reasons.

B. Fan Motor and Bearing: All 1 horsepower (746 watts) to 15 horsepower (11190 watts) motors shall be totally enclosed fan cooled (TEFC) continuous duty rated. The motors shall be dual voltage where applicable. Motors built after October 27th, 1997 shall comply with the government mandated "Energy Policy and Conservation Act" (EPACT) as outlined by the Department of Energy. The bearings shall be self-aligned, ball bearing type permanently sealed and lubricated. The exhaust discharge outlet shall be in compliance with International Mechanical Code and ACGIH recommendations (min. of 36" above roofline). Air intakes, windows, cascade systems, prevailing currents, communication equipment and building aesthetics shall be considered in the final location of the fan.

1. Teflon Shaft Seal: The fan shaft shall be steel and rotate in a non-sparking TEFLON seal to prevent leakage and to prevent hot exhaust gases from coming into contact with the motor bearings.

2. Variable Speed Drive: The motor shall be compatible with a variable speed drive unit.

C. Performance: The delivered volume shall take into account all the static regain of vehicle engine exhaust (based on an airtight connection at the tailpipe), lengths of ductwork, elbows, branches, shut off, wyes, etc. which accumulate the static pressure at the field inlet. The manufacturer's provided fan(s) shall be performance guaranteed.

1. Fan Capacity: The Fan Capacity shall be sized as such as to deliver the required CFM at each hose drop to which the vehicle is attached.

   a. The 4 inch (101.6 mm) hose system shall be designed to deliver a minimum of 500 CFM (2.9 M/Second) at a velocity of 5800 FPM (33.6 M/Second) at the hose and nozzle connection.

   b. The 5 inch (127 mm) hose system shall be designed to deliver a minimum of 750 CFM (4.4 M/Second) at a velocity of 5800 FPM (33.6 M/Second) at the hose and nozzle connection.

c. The 6 inch (152.4 mm) system shall be designed to deliver a minimum of 1100 CFM (6.4 M/Second) at a velocity of 5800 FPM (33.6 M/Second) at the hose and nozzle connection.

D. Location: The preferable fan location shall be on the outside of the fire station as far away from any living quarters as possible so that firefighters would not be disturbed by the system activation. No blower fans shall be mounted inside the fire station. Silencers shall be provided when fan sound pressure level exceeds 64 dB.

2.16 DUCTWORK SYSTEM

A. Ductwork Type and Materials: UMC Class 2 or SMACNA Class II product conveying duct, meet or exceed criteria for construction and performance as outlined in Round Industrial Duct Construction Standards, SMACNA. Materials of construction unless otherwise specified for all ductwork and fittings shall be a minimum G-90 galvanized sheet metal (ASTM A653/A653M). Only when specified, Type 304 stainless steel (ASTM A240/A240M) shall be provided.

B. Ductwork Sizing and Gauges: Round pipe construction, with the range of available sizes not to exceed 10 inches (254 mm) in diameter. Duct gauge shall depend on diameter and a minimum operating pressure of 8 inches water gauge (1990 Pa). Acceptable Gauge and Reinforcement Requirements: Inner duct diameter 4 inches (101.6 mm) through 11 inches (279.4 mm) diameter shall be 22 gauge standard pipe (International Mechanical Code).

C. Ductwork Fittings: Round and have a wall thickness 2 gauges (one even gauge number) heavier than the lightest allowable gauge of the downstream section of duct to which they are connected (International Mechanical Code). Air Duct Branch Entrances: Factory fabricated fittings or factory fabricated duct /tap assemblies. Fittings: Constructed so that air streams converge at angles no greater than 45 degree (International Mechanical Code). All Seams: Continuous stitch welded and if necessary internally sealed to ensure air tightness. Turning elbows shall be stitch-welded and used for all diameters and pressures. They shall be fabricated of 24 gauge galvanized steel and constructed as two piece with continuous welded seam construction fittings similar to those provided by Lindab Inc. Tapered Body Fittings: Used wherever particular fallout is anticipated and where air flow is introduced to the transport duct manifold.

D. Ductwork Design Velocities: Minimum of 3500 FPM (20.3 M/Second) to 4000 FPM (23.2 M/Second) transport velocity. Capture Velocity: 5500 FPM (31.9 M/Second) to 6000 FPM (34.8 M/Second) to extract virtually 100 percent of the exhaust gases.

E. External Ductwork: Sized for the exact inlet and outlet of the exhaust fan blower. An exhaust rain cap shall be supplied and manufactured in accordance with EPA standard for free draft rain cap requirements. Included as an integral part of this rain cap shall be a back draft damper to provide protection from rain and other inclement weather.

F. Exhaust Penetrations: The core drilling shall be properly sized to reduce the diameter of the opening to the smallest possible size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, service-utility connections, and other conditions affecting installation and performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide surface/substrate preparation as required by the manufacturer's printed installation instructions. Do not proceed with installation is in proper condition to receive vehicle exhaust system installation.

3.3 INSTALLATION

A. Install vehicle exhaust system in accord with manufacturer's written instructions, original design and referenced standards.

3.4 ADJUSTING

A. Adjust vehicle exhaust system for proper operation. Replace any parts that prevent the system from operating properly.

3.5 CLEANING

A. Remove all debris caused by installation of the vehicle exhaust system. Clean all exposed surfaces to as fabricated condition and appearance.

3.6 PROTECTION

A. Provide protection of the completed installation until completion of the project. Repair any damage at no additional cost to Owner.

3.7 TRAINING

A. Provide training to fire department personnel in the daily use and maintenance of the vehicle exhaust removal system that has been installed and specified herein. The fire department shall be notified at least 7 days prior to the date scheduled for the training course. Training shall be for all personnel involved with the operation of the exhaust removal system to include all shifts required to man the particular facility. The Training session shall be performed in person by a recognized representative of the manufacturer of the exhaust removal system, in addition a training video shall be provided to the fire department.

1. Provide training to all shifts during their normal shift period.

3.8 WARRANTY

A. Provide a written warrantee for a period of one (1) year from date of shipment for all components.

END OF SECTION 233521

SECTION 235523 – LOW INTENSITY GAS-FIRED RADIANT HEATERS

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 gas-fired low intensity tubular radiant heaters.

1.3 SUBMITTALS

A. Product Data: For each type of gas-fired radiant heater indicated. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: plans, elevations, sections, details, and attachments to other work.

C. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

D. Wiring diagrams: power and control wiring.

E. Coordination drawings: plans, elevations, 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:

F. Illustrations showing how equipment will be attached.

G. Items penetrating roof.

H. Vent and gas piping connections.

I. Operation and Maintenance Data: include in emergency, operation, and maintenance manuals.

J. Warranty: Special warranty specified in Section 1.5.

1.4 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. Equipment shall be certified to the ANSI Z83.20 standard and bear the CSA certification label.

1.5 WARRANTY

A. Warranty Period: (One year on all internal components), (five years on tube exchangers), and (ten years on burner) from date of substantial completion.

PART 2 - PRODUCTS

2.1 TUBULAR INFRARED HEATERS

A. Basis-of-design product: Subject to compliance with requirements, provide Detroit Radiant Products Company; Re-Verber-Ray HL3 Series or a comparable product by one of the following:

1. Reznor/Thomas & Betts Corporation.
2. Modine Inc.
3. Schwank Inc.
4. Calcana, Inc.

B. Fuel type: Burner shall be designed for natural gas having characteristics same as those of gas available at project site.

C. Gas control: Operation shall include a defined input differential. Heater must be CSA Design Certified to operate at an input differential of at least 30% between the low and nominal rated input modes.

D. Combustion chamber: shall be 4 inch O.D. 16ga. Titanium stabilized aluminized steel (150-200MBH to allow for the operating temperature to exceed the 1030F as set forth in the ANSI Z83.20 standard) or aluminized steel (below 150 MBH), finished with a high emissivity rated, corrosion resistant, black coating with an emissivity level documented at .92 or higher. A 409 grade stainless steel chamber shall be used when specified for harsher environments.

E. Emitter tube: shall be 4 inch O.D. 16ga. aluminized steel finished with a high emissivity rated, corrosion resistant, black coating with an emissivity level documented at .92 or higher. A 304 grade stainless steel emitter tube shall be used when specified for harsher environments.

F. Burner type: Unit shall be a positive pressure power burner with a combustion fan upstream of the burner and exhaust gases for component longevity, maximum combustion efficiency, and energy transfer. Negative pressure (pull through) type appliances will not be allowed.

G. Fan enclosure: Combustion fan shall be totally housed inside burner control box and not exposed. Appliances with exposed combustion/exhauster fans shall not be permitted.

H. Burner: Stainless-steel venturi burner. The flame anchoring screen shall have a minimum temperature rating equivalent to 304 grade stainless steel. Non stainless steel burners shall not be permitted.

I. Tube connections: The heater's combustion chamber and radiant emitter tube shall incorporate a 4 inch slip-fit, interlocking connection in which the upstream tube slides into the next tube and is held by a bolted clamp. A butted tube connection system shall not be permitted.

1. Ignition system : Hot surface silicon carbide capable of temperatures achieving 2400 F. Ignitor shall be readily accessible and serviceable without the use of tools. Spark ignition systems shall not be permitted.
2. Reflectors: Shall be .025 polished aluminum with a multi-faceted design which includes reflector end caps. Reflector shall have a polished bright finish with clear visual reflection ability. (A sample will be required at time of submittal). Reflector shall have a minimum of 7 sheet metal bends in its fabrication to optimize downward radiation. Reflectors shall be rotatable from 0 to 45 degrees when required. The heater's reflector hanging system shall be designed to permit expansion while minimizing noise and/or rattles.

3. Control box: Heater's exterior control chassis shall be constructed of corrosion resistant enameled steel. A 304 grade stainless steel housing shall be used when specified for harsher environments.
4. The heater's top cover shall be constructed of ABS plastic material.
5. Air intake: An air intake collar shall be supplied as part of the burner control assembly to accept a 4 inch O.D. supply duct.
6. The heater's control compartment shall be accessible without the use of tools and serviceable while heater is operating.
7. Outdoor modifications are required for any application that will be placed in space defined as outdoors. The rating label shall bear the outdoor certification approval.
8. Heaters shall be equipped with a sight glass allowing a visual inspection of ignitor and burner operation from the floor. Sight glass visible only at a appliance level shall not be permitted.
9. The heaters shall utilize a downstream turbulator baffle for maximum heat transfer.
10. Heater shall be supplied with a stainless steel flexible gas connector.
11. Burner Safety Controls:
    a. Heater controls shall include a safety differential pressure switch to monitor combustion air flow, as to provide complete burner shutdown due to insufficient combustion air or flue blockage.
    b. The heater shall incorporate a self-diagnostic ignition module, and recycle the heater after an inadvertent shutdown.
    c. The heater's control system shall be designed to shut off the gas flow to the main burner in the event either a gas supply or power supply interruption occurs.
    d. The heater's blower motor shall be thermally protected and the motor's impeller shall be balanced.
    e. Heater control assembly shall include three indicator lights that define the unit's operating input ranges. One indicator shall validate air flow. Two indicator lights shall indicate low and high stages.
    f. The heater's air flow control system shall provide a 45 second pre-purge prior to initiating burner operation and a 90 second post-purge upon completion, effectively removing all products of combustion from heat exchanger and/or radiant tubes.
    g. No condensation shall form as a result of combustion in the combustion chamber or radiant tubes while at operating temperatures.
12. Thermostat control shall be two-stage operating on 24 volts.
13. Venting: shall be per manufacturer approval and specifications.
14. Thermostat:
    a. Devices and wiring are specified in Division 23 Section "Instrumentation and Control for HVAC." Thermostat shall be low-voltage type. All

materials and labor for installation shall be provided by contractor under this division.

b. 2-stage, digital programmable wall-mounting type with 50 to 90 deg F (10 to 32 deg C) operating range.

c. Control Transformer: Integrally mounted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired radiant heaters, associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.

B. Suspended units: suspend from substrate using chain hanger kits and building attachments.

C. Maintain manufacturers' published clearances to combustibles.

D. Adhere to manufacturers' installation instructions.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to gas-fired radiant heaters to allow service and maintenance. Refer to manufacturers' instructions for proper gas connection details.

C. Gas Piping: comply with NFPA 54 and manufacturer's installation instructions.

D. Vent Connections: adhere to manufacturers' installation instructions.

E. Electrical Connections: Comply with applicable requirements in Division 26 Sections.

F. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

A. 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. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Obtain adjustment instructions from gas-fired radiant heater manufacturer before making any adjustments to burners or other heating components.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired radiant heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 235523

SECTION 237200 – AIR TO AIR PACKAGED ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged Rooftop air conditioners

1.2 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. AMCA 99—Standards Handbook

C. AMCA 210—Laboratory Methods of Testing Fans for Rating Purposes

D. AMCA 500—Test Methods for Louver, Dampers, and Shutters.

E. AHRI 340/360 - Unitary Large Equipment

F. NEMA MG1—Motors and Generators

G. National Electrical Code.

H. NFPA 70—National Fire Protection Agency.

I. SMACNA—HVAC Duct Construction Standards—Metal and Flexible.

J. UL 900—Test Performance of Air Filter Units.

1.3 SUBMITTALS

A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics and connection requirements.

B. Product Data:

1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, and electrical characteristics and connection requirements.

2. Provide computer generated fan curves with specified operating point clearly plotted.

3. Manufacturer's Installation Instructions.

1.4 OPERATION AND MAINTANENCE DATA

A. Maintenance Data: Provide instructions for installation, maintenance and service

1.5 QUALIFICAITONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalog data on total product.

B. Startup must be done by trained personnel experienced with rooftop equipment.

C. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters and remote controls are in place, bearings lubricated, and manufacturers' installation instructions have been followed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site.

B. Accept products on site and inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Daikin Applied

B. Trane

C. Aaon

2.2 GENERAL DESCRIPTION

A. Furnish as shown on plans, Daikin Applied Rebel Single Zone Heating and Cooling Unit(s) model DPS. Unit performance and electrical characteristics shall be per the job schedule.

B. Configuration: Fabricate as detailed on prints and drawings:

1. Return plenum / economizer section
2. Filter section
3. Cooling coil section
4. Supply fan section
5. Condensing unit section

C. The complete unit shall be cETLUS listed.

D. The unit shall be ASHRAE 90.1-2016 compliant and labeled.

E. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.

F. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.

G. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.

H. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

I. Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first. The manufacturer shall provide an extended 4 year (5 year total) compressor parts only warranty.

2.3 CABINET, CASING, AND FRAME

A. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 1" thick with an R-value of 7.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.

B. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.

C. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.

D. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.4 OUTDOOR/RETURN AIR SECTION

A. Unit shall be provided with a 100% outdoor air hood. The 100% outdoor air hood shall allow outdoor air to enter from the back of the unit, at the draw-through filter section. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream.

B. Daikin Applied UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 CFM/Sq. Ft. of damper area at 1.0 inch static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator.

C. Control of the outdoor dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating type. Damper to open when when supply fan starts, and close when supply fan stops.

2.5 ENERGY RECOVERY

A. The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.

B. The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers

and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers For Energy Recovery Ventilation Equipment.

C. The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.

D. The unit shall have 2" MERV 7 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.

E. The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.

F. The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

G. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.

H. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.

I. The exhaust air fan shall be a direct drive SWSI plenum fan. The exhaust fan shall be sized for the airflow requirements per the construction schedule. The unit controller shall control the exhaust fan to maintain building pressure. A VFD shall be provided for the exhaust fan motor or the exhaust fan motor shall be an ECM motor. The rooftop unit shall have single point electrical power connection and shall be ETL listed.

J. The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.

K. The rooftop unit with the energy recovery wheel shall incorporate the economizer operation. The energy recovery wheel shall have a bypass damper. When the unit is in the economizer mode of operation the energy recovery wheel shall stop and the bypass dampers shall be opened. The outdoor air shall be drawn through the bypass dampers to reduce the pressure drop of the outdoor airstream.

L. The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall stop the wheel. When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

2.6 EXHAUST FAN

A. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.

B. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

C. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

2.7 FILTERS

A. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.

2.8 COOLING COIL

A. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.

B. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.

C. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.

D. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.

E. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

2.9 HOT GAS REHEAT

A. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser

B. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.

C. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.

D. Each coil shall be factory leak tested with high-pressure air under water.

2.10 SUPPLY FAN

A. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.

B. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.

C. Supply fan and motor assembly combinations larger than 8 HP or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.

D. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

E. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.11 HEATING SECTION

A. The rooftop unit shall include an electrical resistance heating coil section. Staged electric heating coil modules shall be factory installed downstream of the supply air fan in the heating section of the rooftop unit. Heating coils shall be constructed of a low watt density, nickel - chromium alloy resistance wire with intermediate supports that include ceramic bushings. The electrical contactors shall be of the full line-breaking type with all the electrical power legs being disconnected when the contactors are not energized. All electrical circuit wiring shall be designed with copper conductors, aluminum wires are not acceptable. Heating element branch circuits shall be individually fused to a maximum of 48 Amps per NEC requirements. The power supply for the electric heater shall be factory wired into the units main power block or disconnect switch.

B. The heating modules shall have an automatic reset, high temperature limit safety protection. A secondary high limit protection shall also be provided that requires a manual reset. An airflow switch shall be provided with the heating module to prevent the electric heater from operating in the event of no airflow.

C. The electric heat elements shall be controlled by the factory installed DDC unit control system. The heater shall have proportional SCR control. The unit controller shall modulate the electric heater to maintain the discharge air temperature setpoint.

D. Field installed heating modules shall require a field ETL certification. Duct heaters mounted within the rooftop unit in the field shall not be acceptable. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the electric heating modules

2.12 HEAT PUMP HEATING

A. The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4-way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.

B. The refrigerant system shall have a pump-down cycle.

C. The unit shall have an electric resistance heating coil for auxiliary heating. When the heat pump operation cannot maintain the discharge air temperature setpoint the electric heating coil shall temper the airstream to the discharge air temperature setpoint.

2.13 CONDENSING SECTION

A. Outdoor coils shall have seamless copper tubes, mechanically bonded into aluminum plate-type fins. The fins shall have full drawn collars to completely cover the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.

B. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0~120°F. Mechanical cooling shall be provided to 25° F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.

C. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material.

D. The unit shall have scroll compressors. One of the compressors shall be a variable capacity compressor providing proportional control. The unit controller shall control the output of the compressor to maintain the discharge air temperature.

E. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.

F. Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for low head pressure compressor starting and increased compressor reliability. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.

G. Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

H. Compressor isolation valves shall be provided on both compressors so that a compressor can be easily removed without evacuating and recovering the entire system refrigerant charge.

2.14 ELECTRICAL

A. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

B. A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

C. Unit shall be equipped with a factory mounted, field-powered GFCI convenience outlet.

2.15 CONTROLS

A. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.

B. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand-alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.

C. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.

D. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.

E. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to

sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.

F. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:

1. Return air temperature.
2. Discharge air temperature.
3. Outdoor air temperature.
4. Space air temperature.
5. Outdoor enthalpy, high/low.
6. Compressor suction temperature and pressure
7. Compressor head pressure and temperature
8. Expansion valve position
9. Condenser fan speed
10. Inverter compressor speed
11. Dirty filter indication.
12. Airflow verification.
13. Cooling status.
14. Control temperature (Changeover).
15. VAV box output status.
16. Cooling status/capacity.
17. Unit status.
18. All time schedules.
19. Active alarms with time and date.
20. Previous alarms with time and date.
21. Optimal start
22. Supply fan and exhaust fan speed.
23. System operating hours.
    a. Fan
    b. Exhaust fan
    c. Cooling
    d. Individual compressor
    e. Heating

f. Economizer

g. Tenant override

G. The user interaction with the keypad shall provide the following:

1. Controls mode
   a. Off manual
   b. Auto
   c. Heat/Cool
   d. Cool only
   e. Heat only
   f. Fan only
2. Occupancy mode
   a. Auto
   b. Occupied
   c. Unoccupied
   d. Tenant override
3. Unit operation changeover control
   a. Return air temperature
   b. Space temperature
   c. Network signal
4. Cooling and heating change-over temperature with dead-band
5. Cooling discharge air temperature (DAT)
6. Supply reset options
   a. Return air temperature
   b. Outdoor air temperature
   c. Space temperature
   d. Airflow (VAV)
   e. Network signal
   f. External (0-10 vdc)
   g. External (0-20 mA)
7. Temperature alarm limits
   a. High supply air temperature
   b. Low supply air temperature
   c. High return air temperature
8. Lockout control for compressors.
9. Compressor inter-stage timers

10. Night setback and setup space temperature.
11. Building static pressure.
12. Economizer changeover
    a. Enthalpy
    b. Dry bulb temperature
13. Currently time and date
14. Tenant override time
15. Occupied/unoccupied time schedule
16. One event schedule
17. Holiday dates and duration
18. Adjustable set points
19. Service mode
    a. Timers normal (all time delays normal)
    b. Timers fast (all time delays 20 sec)

H. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:

1. Zone sensor with tenant override switch
2. Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)

I. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:

1. Airflow
2. Outside air temperature
3. Space temperature
4. Return air temperature
5. External signal of 1-5 vdc
6. External signal of 0-20 mA
7. Network signal

2.16 ROOF CURB

A. A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 14" high and include a nominal 2" x

4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.

END OF SECTION 237200

SECTION 238146 - HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT

1.1 GENERAL

A. The General Conditions, Special Conditions, and the applicable portions of Division 01 of the Specifications are a part of this Section.

1.2 SCOPE

A. Provide all labor, materials, equipment and services required for furnishing and installing all heating, ventilating, and air conditioning equipment and related items as required, specified and shown on the Drawings. Provide all required supply and return piping, condensate piping, ductwork and temperature controls for a complete and operable mechanical system.

B. The design has been based on one manufacturer as specified, changes in ductwork, electrical, piping, supports, etc., required to accommodate other units shall be performed by this Contractor at no additional expense to the Owner.

C. Warranty and Start-Up

1. All equipment manufacturers shall provide factory start-up and first year parts and labor warranty (or as noted herein).

1.3 SHOP DRAWINGS

A. Shop drawings shall be submitted on all heating and ventilating equipment including name of manufacturer, materials of construction, manufacturer's details of installation, connections to other work, fastening, supports, anchors, etc. Shop Drawings shall include all equipment accessories and attachments incidental to a proper and complete installation.

1.4 VIBRATION ISOLATORS

A. Vibration isolators shall be manufactured by Mason Industries Co., Korfund, Amber/Booth Co. or approved equal.

B. Vibration isolators for all HVAC equipment shall be the spring type, sized as recommended by Unit Manufacturer.

1.5 EXHAUST FANS (EF)

A. General

1. Exhaust fans shall be furnished with separate thermal overload protection, disconnect switch as noted on schedule, factory mounted speed controllers on direct drive fans, backdraft dampers. 35 NC maximum allowable sound level at specified operation conditions.

2. Install backdraft dampers as scheduled with undue twisting which may deform damper frame.

B. Ceiling-Mounted Exhaust Fan

1. Description: Centrifugal fans designed for installing in ceiling or wall, or for concealed in-line applications. Unit shall have automatic backdraft damper and be rated for continuous operation.

2. Housing: Galvanized steel lined with acoustical insulation.

3. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds,

motor and fan wheel shall be removable for service.

4. Grille: White polymeric, louvered grille with flange or intake and thumbscrew attachment to fan housing.

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

6. Variable-Speed Controller: Solid-state control to reduce speed form 100 percent to less than 50 percent. Required if noted on the Drawings.

7. Accessories: Manufacturer's standard wall cap and transition fittings, all ventilator schedule for size and additional requirements.

C. Sidewall Propeller Exhaust Fan

1. Description: Fan shall be a wall mounted, direct driven, aluminum propeller exhaust fan.

2. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.

3. Construction: Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The motor shall be mounted on a 14 gauge steel mounting plate and power assembly. The power assembly shall be bolted to a minimum 14 gauge steel wall panel with continuously welded corners and an integral venturi. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM and static pressure. Unit shall be shipped in ISTA Certified Transit Tested Packaging.

4. Coating: All steel fan components shall be LorenizedTM with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a 1.5 to 2.5 mil thick baked powder finish. Paint must exceed 1,000 hours salt spray under ASTM B117 test method.

5. Propeller: Propeller shall be cast aluminum airfoil design with cast aluminum hub. The blade pitch shall be factory set and locked using set screws and roll pin. The hub shall be keyed and locked to the shaft utilizing two set screws or a taper lock bushing. Propeller shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.

6. Motor: Motor shall be NEMA design B with class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure.

D. Manufacturer

1. Exhaust fans shall be Greenheck, Cook, Soler & Palau or approved equivalent. Greenheck catalog numbers are listed as design criteria. Alternate selections will be accepted provided quality, function and characteristics of each exhaust fan shall be as scheduled on the Drawings and specified herein.

2. See fan schedule on Drawings for capacities.

1.8 ELECTRIC UNIT HEATER (EUH-XX)

A. Electric unit heaters shall be as manufactured by Markel, Q-mark, Reddi, Trane, Raywall

or equivalent. Markel model numbers also listed to establish quality only.

B. Furnish and install unit heaters similar to Markel type F2F unit heaters with heating and air delivery capacities as shown on schedule. The cabinet shall be made of 18 gauge die formed, furniture grade steel. Individual adjustable louvers with 30° downward stops shall be furnished to provide desired control of discharge air. All metal surfaces of the casing shall be phosphate coated to resist corrosion and finished in baked enamel. Mounting brackets designed for either ceiling or wall swivel mounting shall be furnished. Heater to be of the draw-through air flow design to eliminate element hot spots and extend design life.

C. The electric heating bank shall consist of metal sheath heating elements. The elements shall have a copper clad steel sheath for strength and corrosion resistance, and aluminum fins for faster heat transfer. Automatic reset thermal over-heat protection, shall be of the linear capillary type wired for instantaneous de-energizing in case of thermal overload. Heating bank to have protective air inlet louvers.

D. Motors shall be of the totally enclosed, continuous heavy-duty all-angle operation equipped with built-in thermal overload protection.

E. Fans shall be aluminum, directly connected to fan motor, designed specifically for unit heater application.

F. Fan voltage control transformers shall be standard for temperature control.

G. All controls shall have pig tails and spade terminals for ease of wiring. All heaters shall be provided with power disconnect switches (factory installed).

H. All heaters shall be U.L. listed and meet the requirements of the National Electrical Code. See schedule on Drawings.

I. The units shall be 208V/3PH/60Hz.

J. Unit shall have integral thermostat.

1.10 ELECTRIC CEILING HEATER (ECH-XX)

A. General

1. Electric ceiling heaters shall be as manufactured by Markel, Raywall or Redd-i.

2. Contractor shall supply and install heavy-duty, ceiling-recessed forced-air electric ceiling heater of the wattage, voltage and phase as indicated on the plans. The heater shall so be designed to provide an even distribution of heated air to the space by drawing return air in the periphery of the heater across the element which shall then be discharged from the center section of the heater by means of an electric motor and axial flow fan blade. Provide with unit mounted disconnect.

3. Heaters shall be recessed mounted as noted on Drawings.

B. Enclosure

1. Heater front shall withstand with less than 1/16" permanent distortion 10.8 ft. Lbs impact and 400 lbs. Static force applied to an 8 sq. in. area at center grille location. The combination return and supply grille assembly shall be constructed of 1/16" x 3/8" rounded edge horizontal steel louvers which shall be spaced for maximum opening of 1/4". Louvers shall be welded at every intersection to three evenly spaced 1/16" diameter vertical members and completely framed in a heavy gauge natural anodized aluminum extrusion. Front assembly shall be

attached to the chassis by hidden tamper-resistant (Allen-head) machine screws. All other parts shall be 16 ga. steel zinc coated both sides finished in a high glass bronze colored baked enamel.

C. Motor

1. Motor shall be a permanently lubricated unit bearing, totally enclosed, shaded pole type with impedance protection. Motors shall operate no more than 1400 RPM and shall be the same voltage as the heater. A protective shield shall surround the motor to separate return air from heated air.

D. Performance

1. Heater shall perform as indicated in schedule.

E. Elements

1. Element assemblies shall consist of two or three corrosion resistant steel sheathed type elements mechanically bonded to common corrosion resistant steel fins. Each sheathed element shall consist of helically coiled nickel chromium alloy resistant wire completely embedded in and surrounded by magnesium oxide, enclosed and swedged into corrosion resistant steel sheaths. Elements shall have 2" cold conductor pins extended into the sheath and shall have a density of no more than 60 watts per inch.

F. Thermal Overload

1. Heaters shall be equipped with a thermal overload which disconnects elements and motor in the event normal operating temperatures are exceeded. For safety, if opened due to abnormal temperatures, thermal overload shall remain open until manually reset by turning heater off for five minutes. Automatic reset thermal overloads which allow the element to continue to cycle under abnormal conditions will not be accepted.

G. Approval

1. Heaters shall be Underwriters' Laboratories listed. Heaters shall conform to Underwriters' Laboratories, Inc. standard 1025. Paragraphs 31.20, 31.21, 31.22, and 31.23, and shall not be required to have any "CAUTION" marking on the front of the heater. Heaters not conforming to these paragraphs will not be acceptable.

H. Controls

1. Heater shall be controlled by integral thermostat. Refer to Schedule.

I. Capacities

1. See schedule on Drawings for capacity and voltage.

1.11 ELECTRIC WALL HEATER (EWH-XX)

A. General

1. Contractor shall supply and install heavy-duty, wall-mounted forced-air electric wall heater of the wattage, voltage and phase as indicated on the plans. The heater shall so be designed to provide an even distribution of heated air to the space by drawing return air in the periphery of the heater across the element which shall then be discharged from the center section of the heater by means of an electric motor and axial flow fan blade. Provide with unit mounted

disconnect.

2. Heaters shall surface mounted or recessed as noted on Drawings.

B. Enclosure

1. Heater front shall withstand with less than 1/16" permanent distortion 10.8 ft. Lbs impact and 400 lbs. Static force applied to an 8 sq. in. area at center grille location. The combination return and supply grille assembly shall be constructed of 1/16" x 3/8" rounded edge horizontal steel louvers which shall be spaced for maximum opening of 1/4". Louvers shall be welded at every intersection to three evenly spaced 1/16" diameter vertical members and completely framed in a heavy gauge natural anodized aluminum extrusion. Front assembly shall be attached to the chassis by hidden tamper-resistant (Allen-head) machine screws. All other parts shall be 16 ga. steel zinc coated both sides finished in a high gloss bronze colored baked enamel.

C. Motor

1. Motor shall be a permanently lubricated unit bearing, totally enclosed, shaded pole type with impedance protection. Motors shall operate no more than 1400 RPM and shall be the same voltage as the heater. A protective shield shall surround the motor to separate return air from heated air.

D. Performance

1. Heater shall perform as indicated in schedule.

E. Elements

1. Element assemblies shall consist of two or three corrosion resistant steel sheathed type elements mechanically bonded to common corrosion resistant steel fins. Each sheathed element shall consist of helically coiled nickel chromium alloy resistant wire completely embedded in and surrounded by magnesium oxide, enclosed and swedged into corrosion resistant steel sheaths. Elements shall have 2" cold conductor pins extended into the sheath and shall have a density of no more than 60 watts per inch.

F. Thermal Overload

1. Heaters shall be equipped with a thermal overload which disconnects elements and motor in the event normal operating temperatures are exceeded. For safety, if opened due to abnormal temperatures, thermal overload shall remain open until manually reset by turning heater off for five minutes. Automatic reset thermal overloads which allow the element to continue to cycle under abnormal conditions will not be accepted.

G. Approval

1. Heaters shall be Underwriters' Laboratories listed. Heaters shall conform to Underwriters' Laboratories, Inc. standard 1025. Paragraphs 31.20, 31.21, 31.22, and 31.23, and shall not be required to have any "CAUTION" marking on the front of the heater. Heaters not conforming to these paragraphs will not be acceptable.

H. Controls

1. Heater shall be controlled by integrally mounted thermostat. Thermostats shall be heavy-duty, hydraulic type with a range of 50 degrees F to 90 degrees F and

with remote sensing bulb placed in the return air. Thermostats shall be electrically rated at least 125% of heater rating. Thermostats shall also act as a disconnect by breaking all ungrounded conductors in the OFF position. Thermostat control knob shall be covered by a 16 ga. tamper-proof access place to prevent adjustment by unauthorized personnel.

I. Capacities

1. See schedule for capacity and voltage.

1.12 ELECTRIC DUCT HEATER (EDH-XX)

A. General

1. Contractor shall supply and install supplemental duct-mounted heating system similar to Hotpod® by Markel. Ducted electric heater shall be of the wattage, voltage and phase as indicated on the plans. The heater shall be provided in accordance with the following:

a. Two-stage operation

b. 120V hard-wired unit

c. Zero clearance enclosure

d. UT8003 low-voltage thermostat

e. Access panels on bottom of unit

1.13 ELECTRIC RADIANT (INFRARED) HEATER

A. Product Description

1. Overhead infrared heater for all indoor heating applications.

B. Housing

1. 20-gauge Stainless Steel housing. Housing shall be ETL listed for both indoor and totally exposed outdoor applications.

C. Reflectors and End Caps

1. 0.040 Gold anodized aluminum reflectors and end caps. Provide with 90-degree wide symmetric reflector pattern.

D. Elements

1. Clear quartz lamps. Coiled tungsten filament located within a sealed quartz envelope, halogen filled, with porcelain end caps and 6" wire pigtail leads. 96% radiant delivered efficiency with high moisture and thermal shock resistance. Instantaneous heat-up and cool-down performance. Available wattages from 500 to 3800 Watts per element. Available voltages from 120 to 600 Volts.

E. Controls

1. Provide with wall-mounted thermostat and SCR controller. Thermostat shall control heating element from 100% at 5 degrees below setpoint (or greater) and 0% at 1.5 degrees above setpoint (OFF).

F. Accessories

1. With adjustable mounting bracket. Refer to Drawings for mounting height.

2. With wire guard.
3. With SCR controller.
4. With power contactor panel.

1.14 CONTAMINANT FILTER MODULE (FM-1)

A. General

1. The Purafil Side Access Double Wall Housing shall be a complete package, designed for the removal of both organic and inorganic contaminants in gas or vapor atmospheres. The manufacturer shall have a minimum of twenty (20) years experience in the design, fabrication and testing of systems that are 99.95% efficient in the removal of these gases. The manufacturer shall be a single source provider of equipment, media and testing services, and be certified to ISO-9001:2008 standards or adhere to quality standards equal to ISO-9001:2008.
2. A 21-point inspection shall be performed by a multi-disciplined inspection team and a record sign-off shall be furnished with each system prior to shipment of unit.

B. Side Access Housing Construction

1. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer.
2. Housing
   a. Unit housing shall be constructed of metallic double-wall, insulated casing. The unit shall be manufactured with monolithic panels for system rigidity.
3. Panels
   a. Double wall housing panels shall have a skin of 0.040 inches thick 3105 aluminum, 24 gauge G90 galvanized steel or 24 gauge 316 stainless steel. The panels shall be seamless, rigid panels of a "cake pan" design with overlapping metal sheets on the front and back bonded together by polyurethane foam. The bonding polyeurethane foam shall have an insulating value of R6.5 per inch
4. Channels
   a. Channels shall be used to join or combine double-wall panels forming part of the double wall unit housing. Channels shall be 1.5625-inch wide straight sections of extruded aluminum. Corner channels and cast joints shall be used to form the outer edges of the unit housing. Internal teke screws and waterproof adhesive shall be used to join channels with double-wall panels.
5. Joints
   a. Cast aluminum joints shall be used to create intersections or joints between individual channels All joints shall be sealed with a waterproof adhesive sealant or approved equal.
6. Internal frames
   a. Unit housing shall be supported internally by rectangular frames. Internal frames shall be located at each internal division of the unit. Internal frames shall support internal tracking for particulate and chemical filters. Internal frames shall be composed of the same metal used to construct double-wall panel housing.
7. Base
   a. Units shall be supported on the bottom by extruded aluminum I-beams 3 inches high and 2.5 inches wide which are 0.25 inches in thickness.

8. Weatherproofing
   a. A weatherproof pan with drip edge will be provided for units weatherproofed for outdoor operation
9. For all filtration sections, extruded aluminum filter slide tracks shall be provided to allow easy access for servicing of filters.
10. Doors
    a. Doors shall be on one side on units up to 4 feet in width and on both sides on units greater than 4 feet in width. All side access doors shall feature gaskets. Closed cell gasketing shall be provided to prevent air leakage around doors and between the doors and filters. The convention for describing door/panel locations is as follows: when facing air discharge, doors shall be on your left.
11. Latches
    a. All housing panels containing hinges shall also feature exterior-mounted adjustable plastic compression latches and handles
12. Track
    a. Purafil side access Particulate filter tracks shall include nylon pile seal to mate with the sealing face of all filters.
    b. The Purafil Side Access System shall include, as a standard feature, the patent-pending Posi-Track™ technology. The Posi-Track technology consists of downward-slanted extruded aluminum filter slide tracks with a micro-glide edge that support MediaPAK™ modular media containment devices (refer to section 3.1) via a corresponding angled notch in the module's frame to create self-sealing pressure and prevent air bypass.
13. Blower Section
    a. Unit to be furnished with a WEG TEFC motor and blower with a direct drive airfoil wheel to assure even, quiet airflow. The MDWPSA shall contain an enclosed blower assembly for outdoor operation. Motor HP will be determined based on the unit configuration. Blower and wiring shall comply with UL 507. Unit to be wired to an external UL junction box for single point electrical connection.
14. Filters
    a. The prefilter shall be a PP-30 woven MERV 8 particulate filter with 90% arrestance and 30-35% dust spot efficiency which meets or exceeds ASHRAE standard 62.
    b. The final filter shall be a JFL-90 MERV 14 filter with 98% arrestance and 90-95% dust spot efficiency.

C. Chemical Media Section(s)
1. The housing shall contain up to five chemical media sections as recommended by Purafil MediaPIK chemical analysis software or chemical analysis equal and designed to accommodate 18.0" (457 mm) or 12.0" (305 mm) deep MediaPAK modular media containment devices, utilizing filter tracks per section 2.3.
2. The MediaPAK module shall have a nominal size of 24.0" wide x 12.0" high x 12.0" deep (610 x 305 x 305 mm) in direction of airflow with a medium bed depth of 3.0" (76.2 mm) and contain 1.0 ft3 (0.028 m3) of Purafil engineered media or a nominal size of 24.0" wide x 6.0" high x 18.0" deep (610 x 152 x 457 mm) and contains 0.5 ft3 (0.014 m3) of Purafil engineered media in the direction of airflow with a medium bed depth of 1.0" (25.4 mm). The MediaPAK module shall be completely recyclable and/or disposable and constructed of 0.125" (3.175 mm) recyclable plastic.

3. The MediaPAK module shall be factory-filled with Purafil engineered and manufactured patented chemical media. The module must be factory-filled and vibrated to eliminate bypass.
4. Pressure drop at maximum air velocity through each chemical media section shall not exceed 1.30 iwg (324 Pa) for a module measuring 24 x 12 x 12 inches/610 x 305 x 305 mm (width x height x depth) or 0.54 iwg (134 Pa) for a module measuring 24 x 6 x 18 inches/610 x 152 x 457 mm (width x height x depth). Maximum air velocity through chemical media section shall be 250 ft/min (1.27 m/sec) for a module measuring 24 x 12 x 12 inches/610 x 305 x 305 mm or 500 ft/min (2.54 m/sec) for a module measuring 24 x 6 x 18 inches/610 x 152 x 457 mm.
5. The MediaPAK module with engineered, dry-chemical media shall be UL Classified Class 2. Manufacturer shall provide documentation.

D. Single-source manufacturer must provide in-house laboratory media life analysis at no-charge for as long as their media product is in operation.

E. Chemical Media shall be similar to Purafil CP Blend Media per the description below and shall capture carcinogens similar to those produced by fire-fighting gear off-gassing.
1. Purafil CP Blend Media is made from an equal mix (by volume) of Purafil Chemisorbant and Purakol media. Purafil Chemisorbant media is generally
2. spherical, porous pellets formed from a combination of activated alumina and other binders, suitably impregnated with potassium permanganate (KMnO4). The sodium permanganate is applied during pellet formation such that it is uniformly distributed throughout the pellet volume and is completely available for reaction with target gases. Purakol media consists of extruded cylindrical, porous pellets formed from a premium virgin activated carbon. No binders are used allowing the carbon completely available for adsorption of target gases.

F. The Side Access Housing Unit shall be a Double Wall Purafil Side Access System (DWPSA) as manufactured by Purafil, Inc. of Doraville, GA. U.S.A. The DWPSA shall be a Purafil Model DWPSA-102-PK-12. The nominal dimensions shall be 16.67" H x 25.50"W x ____L.

G. Warranty
1. Manufacturer shall provide a warranty against defective or deficient equipment, workmanship, and materials under normal use, operation and service. The warranty shall be provided for a period of one year from date of start-up or eighteen months from ship date; whichever occurs first.

H. Preventative Maintenance Scope

1. Manufacturer shall provide sufficient filter media to change the filter media as recommended by the manufacturer for the first full year of occupancy. Mechanical Contractor shall provide labor to change out filter media and train the Owner in proper disposal of media and maintenance of the equipment in the first year of occupancy.

1.15 KITCHEN HOOD EQUIPMENT

A. Type II Exhaust Hoods

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on drawings:

a. Captive-Aire Systems

2. General: Provide hoods of size, type, arrangement, CFM and static pressure performance and capacity as indicated on drawings.
3. Basis-Of-Design, Wall-type: Captive-Aire Systems Model BD-2, 3650.
4. Hood, Wall style: low proximity style, bottom edge at 35 inches to 47 inches above cooking surface.
5. Weld all joints exposed to grease with continuous welds, and make filters/baffles or grease extractors and makeup air diffusers easily accessible for cleaning.
    a. Fabricate hoods according to NSF 2, "Food Equipment."
    b. Hoods shall be listed and labeled, according to UL 710, by a testing agency acceptable to authorities having jurisdiction.
    c. Hoods shall be designed, fabricated and installed according to NFPA 96.
    d. Duct Collars: Minimum 0.0598 inch thick steel at least 4 inches tall, continuously welded to top of hood and at corners with 1 inch flange. Provide duct sizes and quantities as indicated on drawings.
6. Hood Configuration: Exhaust Only.
    a. Exhaust air shall be removed from the rear of the hood.
    b. Makeup air shall be introduced into the room through perforated ceiling diffusers as specified on drawings.
7. Construction: Construct of type 430 stainless steel with a #3 or #4 polish where exposed. Construction shall be dependent on the structural application to minimize distortion and other defects. All seams, joints and penetrations of the hood enclosure to the lower outermost perimeter that directs and captures grease-laden vapor and exhaust gases shall have a liquid-tight continuous external weld in accordance with NFPA 96. Furnish a minimum of four connections for hanger rods. Provide corner hanging angles having 5/8" x 1-1/2" slot pre-punched at the factory, to permit hanging rods installation. Include quarter end panels on each side of the hood.
8. Provide the following features:
    a. A double wall insulated front to eliminate condensation and to increase rigidity. The insulation shall have a flexural modulus of 475 EI, meet UL 181 requirements and be in accordance with NFPA 90A.
    b. 1" insulated end panels on left and right sides for 0" clearance to combustibles on each side of hood.
    c. An integral front baffle to direct grease laden vapors toward the exhaust filter bank.
    d. A built-in wiring chase provided for outlets and electrical controls on the hood face. Chase shall not penetrate the capture area nor require an external chase way.
    e. Removable grease cup.
9. Lighting Fixtures: Surface-mounted, U.L. 1598 compliant incandescent light

fixtures, lamps and globes with lenses sealed vapor-tight, installed and pre-wired to a junction box. The light fixtures shall be installed with a maximum of 4'0" spacing on center and allow up to a 150 watt standard light bulb. Install wiring in a conduit on hood exterior. Number and location of fixtures shall provide a minimum of 52 fc at 36 inches above finished floor. Light switches shall be integrated with hood fan switches and mounted on the front panel of hood utility cabinet.

10. The hood shall be ETL Listed as "Exhaust Hood Without Exhaust Damper," ETL Sanitation Listed and built in accordance with NFPA 96. The hood shall be listed for 450°F cooking surfaces at 150 CFM/ft, 600°F cooking surfaces at 200 CFM/ft, and 700°F cooking surfaces at 220 CFM/ft.

11. Clearance to Combustibles: Hood shall be ETL Listed for 0" clearance to combustibles on front, back, left, right and top sides of the hood.

12. Grease-Filters/Baffles: UL Classified 20 inch high, high-efficiency, single-stage 430 stainless steel filters S-baffle design with a slotted rear baffle, removable for cleaning and sized to fit into standard 2-inch deep hood channel. Fabricate stainless steel filter frame and removable collection cup and pitched trough. Exposed surfaces shall be pitched to drain to collection cup. Test filters/baffles according to UL Standard 1046, "Grease Filters for Exhaust Ducts," by a NRTL acceptable to authorities having jurisdiction. Grease extraction fractional efficiency performance shall remove at least 75% of grease particles five microns in size, and 90% of grease particles seven microns in size and larger, with a corresponding pressure drop not to exceed 1.0 inch, w.g. Provide size and quantity matching capacity of hood and to limit air pressure drop to amount on drawings. The filters shall extend the full length of the hood.

13. Electrical Controls

    a. Switches: Face mounted on right side of hood. Switch plate shall be flush mounted with the face of the hood and shall include 1 rocker switch for hood lights and 1 illuminated rocker switch for hood fan. Switch shall enable the make-up air fan which controls the exhaust fan.

B. Centrifugal Roof Ventilators (EF-04)

1. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings:

    a. Captive-Aire Systems

2. Basis-Of-Design, Roof-type: Captive-Aire Systems model DU-HFA

3. Description: Spun aluminum, roof or wall mounted, direct drive, upblast centrifugal exhaust ventilator. Fan shall be ETL Listed and comply with UL705 (electrical) Standards and CSA Std C22.2, No 113, as well as with UL762 Standards. Fan shall bear the AMCA certified ratings seal for sound and air performance.

4. Housing: Fan windband shall be constructed of heavy gauge aluminum and shall be spun on an automatic lathe to provide consistent dimensions. Horizontal and vertical internal supports shall be used to securely fasten windband to discharge apron to provide rigidity for hinging and added strength to reduce shipping damage. Discharge apron shall have a rolled bead for added strength.

5. Accessories:
   a. Disconnect Switch: Shall be installed in a NEMA3R enclosure and mounted to exterior of wind band for easy access.
   b. Hinge Kit: Heavy duty hinge kit made of 10-gauge galvanized steel shall be provided for exhaust fan roof curb. Kit shall include hardware to attach hinge to curb and hinge to base.
   c. Exhaust fan starter shall be located in heated makeup air unit control panel.
6. Base: Base shall be constructed of galvanized steel for improved rigidity. Base corners shall be welded to provide strength and support for hinging and cleaning and to prevent leakage into building.
7. Wheel: Fan wheel shall be centrifugal backward inclined and non-overloading. Wheels shall be balanced in two planes and in accordance with AMCA standard 204-96, Balance Quality and Vibration Levels for Fans. Wheel blades shall be aerodynamically designed to minimize turbulence, increase efficiency and reduce noise. Wheel blades shall be welded to wheel inlet cone. Should balancing weights be required, they shall be riveted to blades or wheel. Wheel inlet shall overlap fan base inlet for maximum performance and efficiency. Wheel shall be firmly attached to motor shaft with two set screws.
8. Motor & Compartment: Open drip motors shall be permanently lubricated, rated for continuous duty and thermally protected. Motors shall be mounted out of the airstream and furnished at specified voltage, phase and enclosure. Motor mounting plate shall be constructed of heavy gauge galvanized steel. Motor compartment shall be cooled by outside air drawn through an extruded aluminum conduit tube. To seal conduit tube passage and prevent noise, silicone rubber grommets shall isolate conduit tube from fan housing. Motor compartment shall be of a two-piece construction with cap having quick release clips to provide quick and easy access to motor compartment.
9. Grease Spout: A grease spout made of aluminum tubing shall be welded to fan housing. Weld shall be factory tested to ensure it will not leak.
10. Nylon Washers: To provide a tight seal, all fasteners in fan housing shall be backed with nylon washers.
11. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
12. Capacities and Characteristics: Refer to drawings schedules.

C. Direct Gas-fired Makeup Air Units (MAU-01)
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on drawings:
   a. Captive-Aire Systems
   b. Alternate manufacturer subject to Engineer's approval
2. Basis-Of-Design: Captive-Aire Systems model D76.
3. General: Provide direct-fired gas heating and ventilating units, as indicated. Test

units in accordance with ANSI Standard Z83.4a-2001/CSA 3.7a-2001, and furnish with NRTL label. Orientation shall be down discharge as indicated. Provide factory-assembled and tested units and ship as a complete packaged assembly, for outdoor mounting. Include gas burner, FC DW/DI centrifugal blower, motor starter with thermal overload protection, motor and drive assembly, fuel burning and safety equipment, temperature control system and gas piping.

4. Housing Construction: Construct unit housing of 20 gauge G-90 galvanized steel. Fabricate wall and roof panels by forming double-standing, self-locking seams that require no additional support. Caulk floor and wall panels air tight with silicone caulk. Attach casing panels with sheet metal screws or rivets, removable for field servicing large components. Unit base shall be suitable for curb or flat mount. Housing construction shall be suitable for outdoor installation. An observation port shall be located on exterior of unit for observation of main and pilot flames.

5. Vestibule: All controls, gas valves, modulating controls and electrical components shall be mounted within burner vestibule. Burner vestibule shall be an integral part of unit and not extend outside exterior casing of unit and not be exposed to main air stream. Vestibule full-size door shall provide easy access to controls and gas-train components. Blower door shall provide easy access to blower, motor and drives. Access doors shall be provided on both front and backside of unit providing full access to every part of unit.

6. Casing Insulation: Internal ridged board 1" x 1.5" foil face installation shall be installed on roof, walls and base of casing.

7. Base: Construct base of galvanized steel. Base shall be structurally reinforced to accommodate blower assembly and burner.

8. Blowers: Blowers shall be FC DW/DI centrifugal, Class I or II (to meet application requirements), constructed of G-90 galvanized steel. Unit shall have a heavy-duty, solid-steel shaft. Wheels shall be balanced in two planes in accordance with AMCA standard 204-96, "Balance Quality and Vibration Levels for Fans." Wheel blades shall be aerodynamically designed to minimize turbulence, increase efficiency and reduce noise. Wheel blades shall be securely attached to wheel inlet ring. Wheel shall be attached to fan shaft with setscrews and keys. Blower assembly shall be isolated from fan structure with vibration isolators. Listed External Static shall be sum of duct loss, plus duct component static pressure. Test blowers and set at rated speed after installing in factory-assembled unit.

9. Motor & Motor Compartment: Motors shall be heavy-duty ball bearing type and furnished at specified voltage, phase and enclosure. Motor mounting plate shall be constructed of heavy gauge galvanized steel and shall be designed to provide easy adjustment of belt tension. Blower motor shall be Open Drip Proof.

10. Shaft & Bearings: Shafts shall be precision ground and polished. Heavy duty, pre-lubricated bearings shall be selected for a minimum (L50) life in excess of 200,000 hours of operation at maximum cataloged operating speed. They shall be designed for, and individually tested, specifically for use in air handling applications.

11. Belts & Drives: Belts shall be oil and heat resistant, non-static, grip-notch type.

Drives shall be cast type, precision machined and keyed, and secured attached to fan and motor shafts. Fan operating speed shall be factory set using adjustable pitch motor pulleys. All drives shall have a minimum of two (2) V-grooves above 3 HP.

12. Burner: The gas burner shall be direct-fired, draw-through type, using natural gas. Burner shall burn over its entire length at all times when system is in operation. Burner shall have non-clogging, 4302B stainless-steel combustion baffles attached to a ductile aluminum gas-supply section with no moving parts. Burner shall be capable of 92% combustion efficiency with a maximum turndown ratio of up to 30 to 1. Gas burner shall be furnished with a pilot package arranged so that pilot flame lights burner with instantaneous ignition. Pilot assembly includes a flame rod, spark rod and pilot automatically ignited by ignition transformer. A flame-rod rectification system shall be used to prove pilot and main flame. Rear access doors shall provide complete access to burner and pilot assembly. Burner profile plates shall be self-adjusting to operate across complete CFM range of each model heater. Design units for Variable Air Volume applications.

13. Gas Equipment: Gas equipment shall conform to code requirements of International Mechanical Code and NFPA 54. All gas manifold components shall be piped and wired at factory. Include pilot-gas shut-off valve, pilot-gas regulator, pilot-gas valve, main-gas shut-off valve, main-gas regulator, two solenoid valves, modulating-gas valve and burner.

14. Safety Controls: Motor starter with adjustable overloads, air-flow safety switch, electronic flame-safety relay, high-temperature limit switch, main-gas regulator, two safety shutoff valves, modulating-gas valve, adjustable burner ON/OFF inlet air duct-stat to shut off heat when inlet air is sufficiently warm to maintain space temperature and non-fused disconnect.

    a. Exhaust fan motor starter shall be mounted in heater control panel. Exhaust fan power shall be supplied before heater blower power.

15. Inlet Dampers: Provide two-position, motor-operated damper with internal end switch to energize blower-starter circuit when damper is 80% open.

    a. Damper Blades: 16-gauge G-90 galvanized steel, 6" maximum width, mounted on friction-free synthetic bearings.

    b. Damper Edges: PVC coated polyester fabric mechanically locked into blade edge with flexible metal jamb seals.

16. Filters: The filters shall be (2") thick, aluminum mesh, coated with super-filter adhesive. Aluminum-mesh filters shall have aluminum frames with media to be layers of slit and expanded aluminum, varying in pattern to obtain maximum depth loading. Washable 2" filters shall be enclosed in two-piece, die-cut frame with diagonal supports. Frame shall be constructed of heavy-duty beverage board. Filter media is supported on air leaving side by a metal grid.

17. Filter Section: shall be constructed of G-90 galvanized steel with filter supported by internal slides and with removable access panels. Filters shall be provided in a filtered intake.

18. Fresh-Air Inlet Hood: Shall be constructed of G-90 galvanized steel with birdscreen.

19. Roof Curb: 20" curb constructed of 18-gauge aluminized steel and furnished as a complete assembly.

20. Discharge Temperature Control: Provide discharge temperature control of supply/makeup air for range exhaust hoods by modulating burner gas valve.

21. Wiring/Electrical: Provide electrical connection with pre-wired factory-mounted controls. Provide electrical drop as required to provide 115 volt single phase control circuit. Wiring in control enclosures shall be in accordance with National Electrical Code. Provide line voltage motor starters, definite purpose type. Provide all relays, starters, switches, safety controls, conduit and wire, and properly sized safety disconnect switch for complete operating system.

D. Factory welded grease duct

1. Furnish single-wall, factory built, grease duct for use with Type I kitchen hoods, which conforms to the requirements of NFPA-96. Products shall be ETL listed to UL-1978 and CAN/ULC-S662 for venting air and grease vapors from commercial cooking operations as described in NFPA-96.

   a. The duct wall shall be constructed of .036 and .047 thick stainless steel and be available in diameters 8" through 24".

   b. All supports, fan adapters, hood connections, fittings and expansion joints required to install grease duct shall be included.

   c. Roof penetrations shall comply with listed clearance to combustibles. The grease duct will terminate at the fan adapter plate, will be fully welded to the fan adapter plate and the fan adapter plate will be fastened to the curb using a suitably sized fastener provided by others.

   d. Grease duct joints shall be held together by means of formed vee clamps and sealed with 3M Fire Barrier 2000+. Screws used to secure the vee clamps shall be of the hex-head type with flanged stops and tapered "lead in" threads for easy starting. Nuts shall be retained by means of a free-floating cage to allow easy alignment.

   e. Single-Wall Grease Duct shall be installed in accordance with the manufacturer's "Installation, Operation and Maintenance Manual", ETL listing and state and local codes.

   f. Grease duct installed outside of the building shall be protected against accidental damage or vandalism.

   g. Support vertically installed grease duct from the building structure using rigid structural supports. Anchor supports to the structure by welding or bolting steel expansion anchors or concrete inserts. Support horizontally installed grease duct from the building structure using above method. 1/2" Threaded rod and saddles may also be used for the support of horizontal grease duct.

   h. Fans shall be supported independently from the grease duct sections. Protect grease duct from twisting or movement caused by fan torque or vibration.

2. Provide computer generated shop drawings of the grease duct run, complete with individual part labels corresponding to each scheduled piece.

END OF SECTION 238146

SECTION 238146.1 – PREVENTATIVE MAINTENANCE FOR HVAC EQUIPMENT

1.1 GENERAL

A. The General Conditions and Special Conditions and all other Contract Documents shall apply to this Division of the work as well as to all other Divisions.

1.2 SCOPE

A. This Section details the requirements for the Mechanical Contractor to perform scheduled Preventative Maintenance (PM) on the entire mechanical system for the first year of occupancy (starting at date of substantial completion), including the following mechanical equipment:

1. Air-Source Energy Recovery Unit
2. Variable Refrigerant Heat Pump Units
3. Variable Refrigerant Indoor Units
4. Kitchen Make-up Air Unit
5. Mini-split Heat Pump Systems
6. Exhaust Fans (including Kitchen exhaust)
7. Radiant Heating System
8. Electric Heaters
9. Ceiling Fans (Alternate #XX)

B. The HVAC system is an air-source Variable Refrigerant Flow (VRF) heat pump system, with new local control system.

C. All work for this project must comply and be in strict accordance with the Kentucky Building Code, Kentucky Plumbing Code, Kentucky Boiler Code, IMC 2012, NFPA, ADA, NEC and all local codes and regulations.

D. Preventative maintenance shall be performed to verify that equipment has been installed and continues to operate in strict accordance with manufacturer's requirements.

E. In addition to inspecting items as listed below, the Mechanical Contractor shall correct any and all deficiencies found in accordance with the first year parts and labor warranty.

F. NOTE: A representative of LFUCG or the Fire Department must be made aware of PM activities a minimum of one (1) week prior to site visit by the contractor. And Owner's representative may accompany the contractor during the completion of work described herein.

1.3 DESCRIPTION OF SERVICES FOR ENERGY RECOVERY UNIT

A. Four (4) times within the first full year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

1. General Assembly
   a. Verify tight bolts, setscrews, and locking collars.
   b. Inspect sheaves and pulleys for wear and alignment.
   c. Inspect belts for tension, wear, cracks, and glazing.

d. Inspect energy wheel for degradation.

e. Inspect dampers for wear, security, and clearances, if applicable.

f. Replace air filters.

g. Inspect controls prior to startup.

h. Check operation of motorized control valves.

i. Test safety controls and pressure relief valve.

j. Check operation of control circuit.

k. Check operation of motor and starter.

l. Inspect fan.

m. Lubricate fan and motor as required.

n. Inspect air filters.

o. Inspect and adjust belt alignment and tension.

p. Inspect all door gaskets, hinges and latches to verify airtight.

2. Lubrication

a. Lubricate fan bearings.

b. Lubricate energy wheel bearings.

c. Lubricate motor bearings, if applicable.

3. Controls and Safeties

a. Verify the setting of the low temperature safety device.

b. Verify the operation of the cooling control device.

c. Verify the operation of the heating control device.

d. Verify the operation of the control system while the fan is operating.

4. Motor and Starter

a. Clean the starter and cabinet.

b. Inspect the wiring and connections for tightness and signs of overheating and discoloration.

c. Check the condition of the contacts for wear and pitting.

d. Check the contactors for free and smooth operation.

e. Meg the motor and record readings.

f. Check volts and amps of the motor.

1.4 DESCRIPTION OF SERVICES FOR VRF SYSTEM

A. Four (4) times within the first full year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

1. Indoor Unit

a. Inspect coil.

b. Inspect drain pan and drain line.

c. Check and calibrate operating controls and overloads.

d. Tighten motor terminals.

e. Lubricate motor (as applicable).

f. Inspect and change air filters.

g. Inspect all door gaskets, hinges and latches to verify airtight.

h. Check contactor and relays for proper operation.

i. Check indoor unit blade positions.

j.

2. Outdoor Unit

a. Check unit thoroughly for refrigerant leaks.

b. Check and calibrate safety controls and overloads.

c. Meg test compressor motors and record readings.

d. Check main starter, tighten all starter terminals and check contacts for wear.

e. Check oil level in compressor (where applicable).

f. Tighten motor terminals and control panel terminals.

g. Check crankcase heater.

h. Check external interlocks.

i. Check controls operation, schedule and functionality.

j. Check outdoor unit error logs and provide software upgrades, if available.

1.5 DESCRIPTION OF SERVICES FOR KITCHEN MAKE-UP AIR UNIT

A. Annual calibration service – One (1) year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

1. General Assembly

a. Verify tight bolts, setscrews, and locking collars.

b. Inspect sheaves and pulleys for wear and alignment.

c. Inspect belts for tension, wear, cracks, and glazing. Tighten/replace belt as needed, if applicable.

d. Inspect dampers for wear, security, and clearances, if applicable.

e. Replace air filters.

2. Lubrication

a. Lubricate fan bearings.

b. Lubricate motor bearings, if applicable.

3. Controls and Safeties

a. Verify the setting of the low temperature safety device.

b. Verify the operation of the heating control device, if applicable.

c. Verify the operation of the control system while the fan is operating.

4. Motor and Starter

a. Clean the starter and cabinet.

b. Inspect the wiring and connections for tightness and signs of overheating and discoloration.

c. Check the condition of the contacts for wear and pitting.

d. Check the contactors for free and smooth operation.

e. Meg the motor and record readings.

f. Check volts and amps of the motor.

B. Four (4) times within the first full year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

1. Check fuel supply.

2. Inspect burner and controls prior to startup.

3. Start burner and check operating controls.

4. Test safety controls and pressure relief valve.

5. Check operation of control circuit.

6. Check operation of motor and starter.

7. Inspect fan.

8. Lubricate fan and motor as required.

9. Replace air filters.

10. Inspect and adjust belt alignment and tension.

11. Inspect all door gaskets, hinges and latches to verify airtight.

1.6 DESCRIPTION OF SERVICES FOR EXHAUST FANS (INCLUDING KITCHEN AND VEHICLE EXHAUST)

A. Four (4) times within the first full year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

1. Inspect belts for tension, wear, cracks, and glazing. Tighten/replace belt as needed, if applicable.

2. Lubricate motor and bearings, if applicable.

3. Examine discharge openings and fan wheel for debris or obstructions. Remove obstructions and clean as necessary.

4. Check controls for proper operation.

5. Examine and change associated filters, if applicable.

6. Note any undue vibrations emanating from fan housing and correct them.

1.7 DESCRIPTION OF SERVICES FOR RADIANT HEATING SYSTEM

A. Four (4) times within the first full year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

1. General Assembly
   a. Inspect belts for tension, wear, cracks, and glazing.
   b. Inspect dampers for wear, security, and clearances, if applicable.
   c. Examine air intake filters.
2. Lubrication
   a. Lubricate blower bearings.
   b. Lubricate motor bearings, if applicable.
3. Controls and Safeties
   a. Verify the operation of the heating control device.
   b. Verify the operation of the control system while the blower is operating.
   c. Inspect and verify that required clearance from radiant system is maintained.
4. Motor and Starter
   a. Clean the starter and cabinet.
   b. Inspect the wiring and connections for tightness and signs of overheating and discoloration.
   c. Check the condition of the contacts for wear and pitting.
   d. Check the contactors for free and smooth operation.
   e. Meg the motor and record readings.
   f. Check volts and amps of the motor.

1.8 DESCRIPTION OF SERVICES FOR ELECTRIC HEATERS

A. Four (4) times within the first full year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

1. General Assembly
   a. Examine air intake for any obstruction or dust.
   b. Clean heating elements and cabinet or any dust/debris.
2. Controls and Safeties
   a. Verify the operation of the heating control device.
   b. Verify the operation of the control system while the fan is operating.
   c. Inspect and verify that required clearance from the heater is maintained.
3. Motor/Electrical Components
   a. Clean the starter and cabinet.

b. Inspect the wiring and connections for tightness and signs of overheating and discoloration.

c. Check the condition of the contacts for wear and pitting.

d. Check the contactors for free and smooth operation.

1.9 DESCRIPTION OF SERVICES FOR CEILING FANS (ALTERNATE #2)

A. Powerfoil x3.0 Fans

1. Annual calibration service – One (1) year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

a. Check for the presence of the safety cable and shackle. The cable should be wrapped around the I-beam/angle irons leaving as little slack as possible. The shackle should be securely tightened and located on the topside of the I-beam/angle irons.

b. Ensure all mounting bolts are present and torqued to 40 ft·lb (54.2 N·m). There are four bolts for direct mount installations, and 12 bolts for installations with extension tube.

c. Inspect motor terminations inside junction box and tighten if necessary.

d. Check gear reducer for oil leakage. If leakage is present, contact Customer Service at 1-877-BIG-FANS.

e. Ensure all 16 bolts securing airfoils to fan are present and torqued to 29 ft·lb (39 N·m).

f. Ensure airfoils are secured to one another by airfoil retainers (8).

g. Ensure bolts securing winglets to airfoils are securely tightened.

h. Inspect for signs of corrosion, discoloration, pitting, or flaking of metal.

i. Inspect the airfoils and hub for signs of damage or cracks.

2. Four (4) times within the first full year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

a. Check all connections in the fan controller and tighten as needed. Using a vacuum, remove all dust and debris from the inside and outside of the controller.

b. Verify proper fan rotation. The fan should be turning counterclockwise when viewed from the floor.

c. Dust airfoils, motor, and motor housing. If desired, use a gentle cleaner or degreasing agent to polish the foils. Do not use Clorox® or other chlorine based cleaners! This could result in the release of toxic/fatal fumes.

d. Observe the motion of the fan during operation. The fan should not wobble or precess. If any wobble is noticed, ensure the mounting structure is rigid enough to support the fan and that the guy wires, if used, are sufficiently taut. If guy wires were not used, Big Ass Fans suggests installing them. Contact Customer Service at 1-877-BIG-FANS.

B. Haiku Fans

1. Annual calibration service – One (1) year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

   a. Check that the safety cable is properly installed by sliding the wiring cover and trim down the extension tube, and then examining the safety cable and hardware.

   b. Make sure the mounting hardware is securely fastened.

   c. Make sure the hardware securing the airfoils to the fan hub is securely fastened.

   d. Dust the airfoils. Clean them with a damp cloth and ordinary soap and water. Do not use solvents, gasoline, or any other chemical cleaners! These may cause surface distortion and damage to the fan.

   e. Make sure the wires are secured in the terminal strip and the Earth wire is securely connected.

   f. If the hanger plate accessory was installed, make sure the anchor bolts, anchor hook, and safety cable are secured.

2. Four (4) times within the first full year following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

   a. Dust the airfoils. Clean them with a damp cloth and ordinary soap and water. Do not use solvents, gasoline, or any other chemical cleaners! These may cause surface distortion and damage to the fan.

1.10 SUBMITTALS

A. Provide a written report of completed work, operating log, and indicate any uncorrected or corrected deficiencies detected.

B. At date of substantial completion, provide Owner with a comprehensive Preventative Maintenance (PM) Schedule for the upcoming year for their review and acceptance. Contractor is responsible for notifying the Owner of upcoming service days and coordinate with the Owner's schedule as required.

END OF SECTION 238146.1

SECTION 238147A - VARIABLE REFRIGERANT FLOW INDOOR UNITS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995/CAN/CSA-C22.2 No. 236-05 (R2009) – Heating and Cooling Equipment and bear the Listed Mark.

B. All wiring shall be in accordance with the National Electric Code (NEC)/Canadian Electrical Code (CEC).

C. 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.

D. The outdoor unit will be factory charged with R-410A.

1.2 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

1.3 MANUFACTURERS

A. The following manufacturers shall be acceptable:

1. Daikin (Basis of Design)
2. LG
3. Trane
4. Samsung

B. All references to Daikin-specific products referenced within this document shall be interchangeable with the manufacturers' products listed above.

PART 2 - WARRANTY

2.1 GENERAL

A. The manufacturer shall warrant original owner of the non-residential building, multifamily residence or residence in which the Daikin products are installed that under normal use and maintenance for comfort cooling and conditioning applications such products (the "Products") will be free from defects in material and workmanship. This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the ''installation date'' which is one of the two dates below:

1. The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit's rating plate.
2. If the date the unit is originally commissioned cannot be verified, the installation date is three months after the manufacture date.

PART 3 - PERFORMANCE

3.1 DESIGN BASIS

A. The HVAC equipment basis of design is Daikin. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Key General Specifications Alternate Supplier Checklist). In

any event the contractor shall be responsible for all specified items and intents of this document without further compensation.

PART 4 - PRODUCTS

4.1 FXFQ_T – ROUND FLOW SENSING CEILING CASSETTE UNIT

A. General: Daikin indoor unit model FXFQ_T shall be a round flow ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, direct drive DC (ECM) type fan, for installation into the ceiling cavity equipped with an air panel grill. Cassette shall be connected to outdoor unit model REYQ heat recovery model. It shall be a round flow air distribution type, fresh white, impact resistant decoration panel, or optional self-cleaning filter panel. The supply air is distributed via four individually motorized louvers. To save energy and optimize occupancy comfort, the indoor unit shall be equipped with built in occupancy sensor and surface temperature sensor. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control. The indoor units sound pressure shall range from 30 dB(A) to 45 dB(A) at High speed measured at 5 feet below the unit.

B. Indoor Unit:

1. The Daikin indoor unit FXFQ_T shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The round flow supply air flow can be field modified to 23 different airflow patterns to accommodate various installation configurations including corner installations.
5. Return air shall be through the concentric panel, which includes a resin net, mold resistant, antibacterial filter.
6. The indoor units shall be equipped with a condensate pan with antibacterial treatment and condensate pump. The condensate pump provides up to 33-1/2" of lift from bottom of unit to top of drain piping and has a built in safety shutoff and alarm.
7. The indoor units shall be equipped with a return air thermistor.
8. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
9. The voltage range will be 253 volts maximum and 187 volts minimum.
10. To save energy and optimize occupancy comfort, the indoor unit shall be equipped with built in occupancy sensor and surface temperature sensor.
11. Supplied air shall be directed automatically by four individually controlled louvers.

C. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling.
2. Four auto-adjusted louvers shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
3. The airflow of the unit shall have the ability to shut down outlets with multiple patterns allowing for simpler installation in irregular spaces.
4. Fresh air intake shall be possible by way of Daikin's optional fresh air intake kit.
5. A branch duct knockout shall exist for branch ducting of supply air.
6. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
7. Optional high efficiency air filters are available for each model unit.

D. Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.08 to 0.16 HP.
3. The airflow rate shall be available in three manual settings.
4. The DC fan shall be able to automatically adjust the fan speed in 5 speeds based on the space load.
5. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings to allow operation with the high efficiency air filter options.
6. The fan motor shall be thermally protected.

E. Filter:

1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin and antibacterial treatment.
2. Optional high efficiency disposable air filters shall be available.
3. Optional Self-Cleaning Filter Panel, which performs automatic filter cleaning up to once a day, with dust collection box that indicates when to be emptied.

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2, or 3-row cross fin copper evaporator coil with up to 21 FPI design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/4 inch outside diameter PVC.
5. A condensate pan with antibacterial treatment shall be located under the coil.
6. A thermistor will be located on the liquid and gas line.

G. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

H. Control:

1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via BACnet.
3. The unit shall be compatible with a Daikin Intelligent Touch Manager.

4.2 FXZQ – 4 WAY CEILING CASSETTE UNIT (2'x2')

A. General: Daikin indoor unit model FXZQ shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. The cassette shall be connected to outdoor unit model REYQ heat recovery model. It shall be a four-way air distribution type, white (RAL9010), impact resistant with a washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control. The indoor units sound pressure shall range from 29 dB(A) to 34 dB(A) at low speed measured at 5 feet below the unit.

B. Indoor Unit:

1. The Daikin indoor unit FXZQ shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
5. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
6. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21" of lift and has a built in safety shutoff and alarm.
7. The indoor units shall be equipped with a return air thermistor.

8. All electrical components are reached through the decoration panel, which reduces the required side service access.
9. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
10. The voltage range will be 253 volts maximum and 187 volts minimum.

C. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling.
2. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
4. Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet.
5. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

D. Fan:

1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

E. Filter:

1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/32 inch outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 21 inch lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

G. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The

acceptable voltage range shall be 187 to 253 volts.

H. Control:

1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via BACnet.
3. The unit shall be compatible with a Daikin Intelligent Touch Manager.

4.3 FXMQ_PB - CONCEALED CEILING DUCTED UNIT (Med. Static)

A. General: Daikin indoor unit FXMQ_PB shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, direct-drive DC (ECM) type fan with auto CFM adjustment at commissioning, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. Ducted unit shall be connected to outdoor unit model REYQ heat recovery model. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control. Included as standard equipment, a condensate drain pan and drain pump kit that pumps to 18-3/8" from the drain pipe opening. The indoor units sound pressure shall range from 29 dB(A) to 43 dB(A) at low speed measured 5 feet below the ducted unit.

B. Indoor Unit:

1. The Daikin indoor unit FXMQ_PB shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall be equipment with automatically adjusting external static pressure logic that is selectable during commissioning. This adjusts the airflow based on the installed external static pressure.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 18-3/8" of lift from the center of the drain outlet and has a built in safety shutoff and alarm.
5. The indoor units shall be equipped with a return air thermistor.
6. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
7. The voltage range will be 253 volts maximum and 187 volts minimum.

C. Unit Cabinet:

1. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

D. Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The unit shall be equipment with automatically adjusting external static pressure logic selectable during commissioning.
3. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range of 0.12 to 0.47 HP respectively.
4. The airflow rate shall be available in three settings.
5. The fan motor shall be thermally protected.
6. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

E. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 3 row cross fin copper evaporator coil with 15 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4" outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with an 18-3/8" lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

F. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.

G. Control:

1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via BACnet.
3. The unit shall be compatible with a Daikin Intelligent Touch Manager.

4.4 FXAQ – WALL MOUNTED UNIT

A. General: Daikin indoor unit FXAQ shall be a wall mounted fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation onto a wall within a conditioned space. This compact design with finished white casing shall be available in capacities from 7,500 Btu/h to 24,000 Btu/h. Wall mounted unit shall be connected to outdoor unit model REYQ heat recovery model. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies

while limiting changes in room temperature when used with Daikin remote control. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment. The indoor units sound pressure shall range from 31 dB(A) to 41 dB(A) at low speed measured at 3.3 feet below and from the unit.

B. Indoor Unit:

1. The Daikin indoor unit FXAQ shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. Return air shall be through a resin net mold resistant filter.
5. The indoor units shall be equipped with a condensate pan.
6. The indoor units shall be equipped with a return air thermistor.
7. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
8. The voltage range will be 253 volts maximum and 187 volts minimum.

C. Unit Cabinet:

1. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

D. Fan:

1. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.054 to 0.058 HP.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

E. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 14 fpi design

completely factory tested.

4. The refrigerant connections shall be flare connections and the condensate will be 11/16 inch outside diameter PVC.

5. A thermistor will be located on the liquid and gas line.

6. A condensate pan shall be located in the unit.

F. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.

G. Control:

1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.

2. The unit shall be compatible with interfacing with a BMS system via BACnet.

3. The unit shall be compatible with a Daikin Intelligent Touch Manager.

H. Required Accessories:

1. Condensate pump

PART 5 - HVAC EQUIPMENT ALTERNATE (GENERAL INFORMATION)

5.1 GENERAL

A. The alternate equipment supplier shall provide to the bidding mechanical contractor a complete equipment data package. This package shall include, but is not limited to, equipment capacities at the design condition, power requirements, indoor units CFM/static pressures, fan curves, installation requirements, and physical dimensions. Nominal performance data is not acceptable.

B. The mechanical contractor shall request and receive the equipment data package two (2) days prior to bid date and submit this package with the alternate bid.

C. The mechanical contractor shall list the equipment supplier and submit the required data package with the bid detailing a complete comparison of the proposed alternate equipment to the specified equipment and the associated cost reduction of the alternate equipment. The contractor bids an alternate manufacturer with full knowledge that that manufactures product may not be acceptable or approved.

D. The alternate equipment supplier shall furnish a complete drawing package to the mechanical contractor two (2) days prior to bid day for bidding and installation. The HVAC and electrical series design documents will be made available in electronic format for use by the equipment supplier in preparing their drawings. The alternate equipment supplier shall prepare the following drawings:

1. XXX HVAC Floor Plan

2. XXX HVAC Refrigerant Piping Plan

3. XXX HVAC Refrigerant Piping/Controls Details

4. XXX HVAC Details

5. XXX HVAC Schedules

E. The alternate equipment supplier shall draft all piping circuits, components, overall build-

ing control schematic, detailed control wiring diagrams, system details and schedules for their system. The drawings shall convey all requirements to successfully install the alternate equipment supplier's system.

F. The submitted documents shall be complete system designs and show no less information than the HVAC equipment/controls contract bid documents.

G. The equipment supplier shall submit as part of the equipment data package outdoor unit data sheets. Data sheets to include the following:

1. Capacities at project design conditions: Cooling
2. Cooling (Btu/h)
3. Cooling Input Power
4. (kW)

H. Capacities at project design conditions: Heating

1. Heating (Btu/h)
2. Heating Input Power
3. (kW)

I. The submitted capacity and efficiency performance must meet or exceed the listed performance on the schedule at the designed outdoor ambient, and indoor space temperature conditions including de-rate factors for defrost and refrigerant piping lengths.

1. Operating Temperature Range:
   a. Cooling
   b. Heating
2. Power Supply:
   a. Maximum Circuit Amps (MCA)
   b. Maximum Overcurrent Protection Amps (MOP)
   c. Maximum Starting Current (MSC)
   d. Outdoor Fan Motor
3. Refrigerant:
   a. Refrigerant Type/Charge
   b. Control
4. Unit Data:
   a. Max. Number of Indoor Units
   b. Sound Pressure Level at 3ft. (dBA)
   c. Weight (lbs)
   d. Dimensions

J. The equipment supplier shall guarantee the performance of their system and all published data submitted. Performance shall be based on the design criteria below.

1. Room Temperature (Cooling): _____
2. Room Temperature (Heating): _____
3. Ambient Temperature (Summer): _____
4. Ambient Temperature (Winter): _____
5. Defrost De-rate Factor: _____

6. Refrigerant Piping Loss in cooling (correction factor): _____

7. Refrigerant Piping Loss in heating (correction factor): _____

K. The alternate equipment supplier shall submit with bid, indoor unit data sheets. Data sheets to include the following:

1. Capacities:
2. Cooling (Btu/h)
3. Heating (Btu/h)
4. Air Flow (CFM)
5. External Static Pressure (ESP)
6. Electrical Data (MCA, MOP, MSC)
7. Weight (lbs)
8. Dimensions

END OF SECTION 238147A

SECTION 238147B - VARIABLE REFRIGERANT FLOW OUTDOOR UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Variable refrigerant volume HVAC system includes:

1. Outdoor/Condensing unit(s):
2. Branch Selector Boxes
   a. **Input information as required*
3. Indoor Units
   a. **Input information as required*

1.2 QUALITY ASSURANCE

A. MANUFACTURER QUALIFICATIONS:

1. The units shall be tested by a National Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.
2. All wiring shall be in accordance with the National Electric Code (NEC).
3. 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.
4. The condensing unit will be factory charged with R410A.

1.3 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

1.4 WARRANTY

A. The manufacturer shall warrant the original owner of the non-residential building, multifamily residence or residence in which the Daikin products are installed that under normal use and maintenance for comfort cooling and conditioning applications such products (the "Products") will be free from defects in material and workmanship. This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the ''installation date'' which is one of the two dates below:

1. The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit's rating plate.
2. If the date the unit is originally commissioned cannot be verified, the installation date is three months after the manufacture date.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following manufacturers shall be acceptable:

a. Daikin (Basis of Design)
b. LG
c. Trane

d. Samsung

B. All references to Daikin-specific products referenced within this document shall be interchangeable with the manufacturers' products listed above.

2.2 HVAC SYSTEM DESIGN

A. SYSTEM DESCRIPTION:

1. The variable capacity heat recovery air conditioning system shall be a Variable Refrigerant Volume Series (heat or cool model) system as specified.

2. The system shall consist of multiple evaporators, branch selector boxes, REFNET™ joints and headers, a three-pipe refrigeration distribution system using PID control and Daikin VRV® condenser unit.

3. The condenser shall be a direct expansion (DX), air-cooled heat recovery, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant.

4. All zones are each capable of operating separately with individual temperature control.

5. A dedicated hot gas pipe shall be required to ensure optimum heating operation performance.

   a. Two-pipe, heat recovery systems utilizing a lower temperature mixed liquid/gas refrigerant to perform heat recovery are not acceptable due to reduced heating capabilities.

6. The Daikin condensing unit shall be interconnected to indoor unit fac coil units in accordance with Daikin's engineering data book detailing each available indoor unit.

   a. The indoor units shall be connected to the condensing unit utilizing Daikin's REFNET™ specified piping joints and headers to ensure correct refrigerant flow and balancing. T style joints are not acceptable for a variable refrigerant system.

7. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with each branch of the cool/heat selector box. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Manager or a BMS interface.

8. Branch selector boxes:

   a. The branch selector boxes shall have the capacity to control up to 290 MBH (cooling) downstream of the branch selector box.

   b. Each branch of the branch selector box shall consist of three electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the box and main processor and between the box and indoor units.

   c. The branch selector box shall control the operational mode of the subordinate indoor units. The use of three EEV's ensures continuous heating during defrost (multiple condenser systems), no heating impact during changeover and reduced sound levels.

d. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.

B. VRV IV FEATURES AND BENEFITS

1. Voltage Platform - Heat pump condensing units shall be available with a 208-230V/3ph/60Hz power supply.
2. Advanced Zoning - A single system shall provide for up to 64 zones.
3. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve with 2000 positions for independent control.
4. VFD Inverter Control and Variable Refrigerant Temperature - Each condensing unit shall use high efficiency, variable speed all "inverter" compressor(s) coupled with inverter fan motors to optimize part load performance. The system capacity and refrigerant temperatures shall be modulated automatically to set suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads. The control will be automatic and customizable depending on load and weather conditions.
   a. Indoor shall use PID to control superheat to deliver a comfortable room temperature condition and optimize efficiency.
5. Configurator software - Each system shall be available with configurator software package to allow for remote configuration of operational settings and also for assessment of operational data and error codes.
   a. If this software is not provided by an alternate manufacturer, for each individual outdoor unit the contractor shall do the settings manually and keep detailed records for future maintenance purposes.
6. Autocharging - Each system shall have a refrigerant auto-charging function.
7. Defrost Heating – Multiple condenser VRV systems shall maintain continuous heating during defrost operation. Reverse cycle (cooling mode) defrost operation shall not be permitted due to the potential reduction in space temperature.
8. Oil Return Heating – Multiple condenser VRV systems 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.
9. Low Ambient Cooling - Each system shall require low ambient cooling operation to -4°F DB (-20°CDB). Wind hoods will be required to cover the condenser coil in order to achieve the -4°F DB (-20°CDB) cooling operation and to serve as hail guards for severe weather protection of the condesner coils.
10. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve for independent control.
11. Flexible Design –
    a. Systems shall be capable of up to 540ft (165m) [623 ft. (190m) equivalent] of linear piping between the condensing unit and furthest located indoor unit.
    b. Systems shall be capable of up to 3,280ft (1,000m) total "one-way"

piping in the piping network.

12. Oil return – Each system shall be furnished with a centrifugal oil separator and active oil recovery cycle.

13. Simple wiring – Systems shall use 16/18 AWG, 2 wire, stranded, non-shielded and non-polarized daisy chain control wiring.

14. Space saving – Each system shall have a condensing unit module footprint no larger than 48-7/8" x 30-3/16" (1694mm x 1242mm x 767mm).

15. Advanced diagnostics – Systems shall include a self-diagnostic, auto-check function to detect a malfunction and display the type and location.

16. Each condensing unit shall incorporate contacts for electrical demand shedding with optional 3 stage demand control with 12 customizable demand settings.

17. Advanced controls – Each system shall have at least one remote controller capable of controlling up to 16 indoor units.

18. Each system shall be capable of integrating with open protocol BACnet and LonWorks building management systems.

19. Low sound levels - Each system shall use indoor and condensing units with quiet operation as low as 27 dB(A).

C. PERFORMANCE:

1. Cooling or Cooling Dominant Operation:

a. The operating range in cooling or cooling dominant simultaneous cooling/heating will be 23°FDB (-5°CDB) ~ 110°FDB (43.3°CDB).

b. Cooling mode indoor room temperature range will be 57-77°FWB (13.8 - 25°CWB).

c. Each system as standard shall be capable of onsite reprogramming to allow low ambient cooling operation down to -4°FDB (-20°CDB).

2. Heating or Heating Dominant Operation:

a. The operating range in heating or heating dominant simultaneous cooling/heating will be -22° – 61°FWB (-30 – 16°CWB).

1) If an alternate equipment manufacturer is selected, the mechanical contractor shall provide, at their own risk and cost, all additional material and labor to meet low ambient operating condition and performance

b. Heating mode indoor room temperature range will be 59°FDB - 80°F DB (15°CDB – 26.7°CDB).

2.3 EQUIPMENT

A. ELECTRICAL:

1. The power supply to the condensing unit shall be:

POWER SUPPLY VOLTAGE	VOLTAGE RANGE
208-230V / 3ph / 60 Hz	187V – 253V (±10%)

B. WIRING:

1. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable.
2. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.
3. The control wiring maximum lengths shall be as shown below:

	CONDENSER TO INDOOR UNIT	CONDENSER TO CENTRAL CONTROLLER	INDOOR UNIT TO REMOTE CONTROL
CONTROL WIRING LENGTH	6,560 ft (2,000 m)	3,280 ft (1,000 m)	1,640 ft (500 m)
WIRE TYPE	16/18 AWG, 2 wire, non-polarity, non-shielded, stranded		

C. REFRIGERANT PIPING:

1. The system shall be capable of refrigerant piping up to 540ft (165m) actual or 623ft (190m) equivalent from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280ft (1,000m) of piping between the condensing and indoor units with 295ft (90m) maximum vertical difference, without any oil traps or additional components.
2. REFNET™ piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance.
   a. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

D. PAINT/CORROSION RESISTANCE:

1. Paint and corrosion resistance shall be at a minimum per the table below:

COMPONENT	VRV IV		
	BASE MATERIAL	SURFACE TREATMENT	COATING THICKNESS
			External & Internal Surface
EXTERNAL PANEL BASE	Galvanized steel	POLYESTER	≧1.5 mils
EXTERNAL FRONT PANEL	Galvanized steel	POLYESTER	≧1.5 mils

PILLAR	Galvanized steel	POLYESTER	≧1.5 mils
COMPRESSOR COVER	ASTM material	Resin Paint	≧0. 78 mils
FIN GUARD	Iron wire	Resin Paint	≧0. 79 mils
FAN GUARD AND DRUM	Polypropylene	No treatment required	N/A
FAN	Acrylonitrile - glass	No treatment required	N/A
FAN MOTOR FRAME	Resin	No treatment required	N/A
FAN MOTOR SHAFT	Carbon steel	No treatment required	N/A
FAN MOTOR SUPPORT	Galvanized steel	POLYESTER	≧1.5 mils
HEAT EXCHANGERS (FIN ONLY)	Aluminum	Polymer Anti-corrosion surface treatment	Salt Spray 1000 hours, blister rating 10
ELECTRICAL PARTS BOX	Hot-dip zinc-coated steel	No treatment required	N/A
ELECTRICAL PARTS BOARD	Glass cloth / Glass nonwoven cloth material	Insulation Varnish	No specific thickness
SCREWS	Carbon steel wire rods	High corrosion resistance treatment	≧0. 28 mils

2.4 OUTDOOR/CONDENSING UNIT

A. GENERAL:

1. The condensing unit is designed specifically for use with VRV series components.
2. The condensing unit shall be factory assembled in the USA and pre-wired with all necessary electronic and refrigerant controls.
3. 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 accumulator.
4. Liquid and suction lines must be individually insulated between the condensing and indoor units.

5. The condensing unit can be wired and piped with access from the left, right, rear or bottom.

6. The connection ratio of indoor units to condensing unit shall be permitted up to 200% of nominal capacity.

7. Each condensing system shall be able to support the connection of up to 64 indoor units dependent on the model of the condensing unit.

8. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time or via an external input.

9. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.

10. The unit shall incorporate an auto-charging feature to ensure optimum performance. Manual changing should be support with a minimum of 2 hours of system operation data to ensure correct operation.

11. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.

12. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

13. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.

14. 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.

15. The condensing unit shall be capable of heating operation at -13°F (-25°C) wet bulb ambient temperature without additional low ambient controls or an auxiliary heat source.

16. The multiple condenser VRV systems shall continue to provide heat to the indoor units in heating operation while in the defrost mode.

B. UNIT CABINET:

1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed galvanized steel panels coated with a baked enamel finish.

C. FAN:

1. The condensing unit shall consist of one or more propeller type, direct-drive 350, 400 or 800W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.

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 shall be a vertical discharge configuration with a nominal airflow maximum range of 5,544 CFM to 24,684 CFM dependent on model specified.

4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.

5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

D. SOUND:

1. Nominal sound pressure levels shall be less than or equal to 68 dB(A).

2. 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.

OPERATION SOUND dB(A)	NIGHT MODE SOUND PRESSURE LEVEL dB(A) APPROX.
Level 1	55
Level 2	50
Level 3	45

E. CONDENSER COIL:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.

2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.

3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.

4. The fins shall be coated with an anti-corrosion hydrophilic blue coating as standard from factory with a salt spray test rating of 1000hr per ASTM test standards.

5. The outdoor coil shall have three-circuit heat exchanger design eliminating the need for a drain pan heater. The lower part of the coil shall be used for inverter cooling and be on or off during heating operation enhancing the defrost operation.

   a. An alternate manufacturer must provide a drain pan heater to enable adequate defrosting of the unit in defrost operation.

6. The condensing unit shall be factory equipped with condenser coil guards on all sides.

F. COMPRESSOR:

1. The Daikin inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
    a. 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) shall be controlled to eliminate deviation from target value.
        1) Non –inverter-driven compressors, which may cause starting motor current to exceed the nominal motor current (RLA) and require larger wire sizing, shall not be allowed.
2. The inverter driven compressors in the condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll "G-type" or "J-type".
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.
    a. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 3% to 100%.
5. The compressor's motor shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be spring mounted to avoid the transmission of vibration eliminating the standard need for spring insolation.
9. In the event of compressor failure, 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 manually activated to specifically address this condition for single module and manifolded systems.
10. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours. When connected to a central control system sequential start is activated for all system on each DIII network.

2.5 BRANCH SELECTOR UNITS

A. GENERAL:

1. The branch selector boxes are designed specifically for use with VRV IV series heat recovery system components.
    a. These selector boxes shall be factory assembled, wired, and piped.

b. These branch controllers must be run tested at the factory.

c. These selector boxes must be mounted indoors.

d. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.

B. UNIT CABINET

1. These units shall have a galvanized steel plate casing.

2. Each cabinet shall house 3 electronic expansion valves for refrigerant control per branch.

3. The cabinet shall contain one subcooling heat exchanger per branch.

4. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.

5. Nominal sound pressure levels must be measured and published on the submittals by the manufacturer. These sound levels must not exceed the values below.

a. If an alternative manufacturer is selected, the mechanical contractor shall provide, at their own cost and expense, any additional material and labor to meet the published sound levels above.

MODEL NUMBER	SOUND LEVEL dB(A) OPERATION	SOUND LEVEL dB(A) MAX
BSQ36TVJ	35	40
BSQ60TVJ	41	45
BSQ96TVJ	41	45
BS4Q54TVJ	38	45
BS6Q54TVJ	39	47
BS8Q54TVJ	39	47
BS10Q54TVJ	40	48
BS12Q54TVJ	40	48

6. DIMENSIONS (H x L x W)

a. BSQ_T unit shall be no larger than 8-1/8" x 15-1/4" x 12-13/16" (206.4mm x 387.4mm x 325.4mm).

b. BS4Q_T shall be no larger than 11-3/4" x 18-15/16" x 14-9/16" (298.5mm x 481mm x 370mm).

c. BS(6/8)Q_T shall be no larger than 11-3/4" x 22-13/16" x 18-15/16" (298.5mm x 579.4mm x 481mm).

d. BS(10/12)Q_T shall be no larger than 11-3/4" x 32-5/16" x 18-15/16"

(298.5mm x 821mm x 481mm).

7. REFRIGERANT VALVES:

   a. The unit shall be furnished with 3 electronic expansion valves per branch to control the direction of refrigerant flow. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.

   b. The refrigerant connections must be of the braze type.

   c. In multi-port units, each port shall have its own electronic expansion valves. If common expansion/solenoid valves are used, redundancy must be provided.

   d. Each circuit shall have at least one (36,000 Btu/h indoor unit or smaller for the BSQ36TVJ, 54,000 Btu/h indoor unit or smaller for the BS(4/6/8/10/12)Q54TVJ, 60,000 Btu/h indoor unit or smaller for the BSQ60TVJ and 96,000 Btu/h indoor unit or smaller for the BSQ96TVJ) branch selector box.

   e. Multiple indoor units may be connected to a branch selector box with the use of a REFNET™ joint provided they are within the capacity range of the branch selector.

8. CONDENSTATE REMOVAL:

   a. The unit shall not require provisions for condensate removal. A safety device or secondary drain pan shall be installed by the mechanical contractor to comply with the applicable mechanical code, if an alternate manufacturer is selected.

9. ELECTRICAL:

   a. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.

   b. The unit shall be capable of operation within the limits of 187 volts to 255 volts.

   c. The minimum circuit amps (MCA) shall be 0.1 and the maximum overcurrent protection amps (MOP) shall be 15.

   d. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded 2 conductor cable.

END OF SECTION 238147B

APPENDIX A

HVAC EQUIPMENT ALTERNATE (GENERAL INFORMATION)

1) The alternate equipment supplier shall provide to the bidding mechanical contractor a complete equipment data package.

   a) This package shall include, but is not limited to, equipment capacities at the design condition, power requirements, indoor units CFM/static pressures, fan curves, installation requirements, and physical dimensions. Nominal performance data is not acceptable.

   b) The mechanical contractor shall request and receive the equipment data package two (2) days prior to bid date and submit this package with the alternate bid.

   c) The mechanical contractor shall list the equipment supplier and submit the required data package with the bid detailing a complete comparison of the proposed alternate equipment to the specified equipment and the associated cost reduction of the alternate equipment. The contractor bids an alternate manufacturer with full knowledge that that manufactures product may not be acceptable or approved.

   d) All equipment must have visible and permanent label clearly identifying the original manufacturer of the equipment. These labels shall have original manufacturer's name and contact information and be located both inside and outside the equipment and on all equipment-related literature. Submittals shall include the above statement as confirmation by supplier that all conditions are agreed to and complied to. Failure to comply with these requirements shall be sufficient cause for rejection of the submittal and product with no further consideration.

2) The alternate equipment supplier shall furnish a complete drawing package to the mechanical contractor two (2) days prior to bid day for bidding and installation.

   a) The HVAC and electrical series design documents will be made available in electronic format for use by the equipment supplier in preparing their drawings.

   b) The alternate equipment supplier shall prepare the following drawings:

      i) XXX HVAC Floor Plan

      ii) XXX HVAC Refrigerant Piping Plan

      iii) XXX HVAC Refrigerant Piping/Controls Details

      iv) XXX HVAC Details

      v) XXX HVAC Schedules

   c) The alternate equipment supplier shall draft all piping circuits, components, overall building control schematic, detailed control wiring diagrams, system details and schedules for their system. The drawings shall convey all requirements to successfully install the alternate equipment supplier's system.

   d) The submitted documents shall be complete system designs and show no less information than the HVAC equipment/controls contract bid documents.

3) The equipment supplier shall submit, as part of the equipment data package, condensing unit data sheets. Data sheets to include the following:

   a) COOLING capacities at project design conditions:

      i) Cooling (Btu/h)

ii) Cooling Input Power:
(1) Ducted (kW)
(2) Ductless (kW)
(3) Mixed (kW)

iii) Part Load IEER:
(1) Ducted
(2) Ductless
(3) Mixed

iv) SCHE

v) Full Load EER:
(1) Ducted
(2) Ductless
(3) Mixed

b) HEATING capacities at project design conditions:

i) Heating (Btu/h)

ii) Heating Input Power:
(1) Ducted (kW)
(2) Ductless (kW)
(3) Mixed (kW)

iii) Full Load COP @ 47°F:
(1) Ducted
(2) Ductless
(3) Mixed

iv) Full Load COP @ 17°F:
(1) Ducted
(2) Ductless
(3) Mixed

c) The submitted capacity and efficiency performance must meet or exceed the listed performance on the schedule at the designed space conditions including de-rate factors for defrost if applicable and refrigerant piping losses.

i) OPERATING TEMPERATURE RANGE:
(1) Cooling
(2) Heating

ii) POWER SUPPLY:
(1) Maximum Circuit Amps (MCA)

(2) Maximum Overcurrent Protection Amps (MOP)

(3) Maximum Starting Current (MSC)

(4) Condenser Fan Motor

iii) REFRIGERANT:

(1) Refrigerant type and charge details including field charge for piping to ensure code compliance.

(2) Control of refrigerant temperature based on weather and load or alternative function.

iv) UNIT DATA:

(1) Max. number of indoor units

(2) Sound pressure level at 3ft (dBA)

(3) Weight (lbs)

(4) Dimensions

(5) Demand limit function description

(6) Details on sequential start functionality

(7) Coil anticorrosion data

4) The equipment supplier shall guarantee the performance of their system and all published data submitted. Performance shall be based on the design criteria below.

a) Room Temperature (Cooling)

b) Room Temperature (Heating)

c) Ambient Temperature (Summer)

d) Ambient Temperature (Winter)

e) Defrost De-rate Factor

f) Refrigerant Piping Loss

5) The alternate equipment supplier shall submit with bid, indoor unit data sheets. Data sheets to include the following:

a) Capacities at project design conditions:

i) Cooling (Btu/h)

ii) Cooling Input Power (kW)

iii) Part Load IEER

iv) SCHE

v) Full Load EER

vi) Heating (Btu/h)

vii) Heating Input Power (kW)

viii) Full Load COP@47°F

ix) Full Load COP@17°F

x) Air Flow (CFM)

b) External Static Pressure (ESP)

c) Electrical Data (MAC, MOP, MSC, RLA)

d) Weight (lbs)

e) Dimensions

6) The equipment supplier shall provide a certificate which states that the equipment has a minimum salt spray resistance of 1000 hours.

7) The equipment supplier shall submit the warranty certificate to the mechanical contractor.

SECTION 260500 – GENERAL REQUIREMENTS

1.1 GENERAL REQUIREMENTS

A. All drawings and general provisions of the contract, including the General and Supplementary Conditions and Division 01 Specifications apply to all specifications in Divisions 26, 27 and 28. In addition, the general requirements described within this specification section, 260500 General Requirements, apply to all specifications in Division 26, 27, 28 and the Contract Drawings.

B. The contractor is responsible for obtaining and paying for all building permits, fees, licenses and inspections required by the governing agencies.

C. The drawings and specifications constitute the Contract Documents. They complement each other. All items shown on the drawings and/or listed in the specifications shall be provided and installed by the Contractor unless specifically noted that it will be provided and/or installed by others. In the event there is a conflict within the Contract Documents, the Contractor shall notify the Engineer immediately. If a clarification is not given, the Contractor shall bid the more stringent of the two requirements.

D. Any materials, labor, equipment or services not specifically mentioned herein which may be necessary to complete any part of the electrical systems described in the drawings and/or specifications shall be included as part of the Contract.

E. References in the Contract Documents to any specific manufacturer and/or catalog numbers are intended to establish a standard of quality and not to limit competition. Proposed equivalent manufacturers shall be provided to the Engineer a minimum of 14 days prior to bid.

F. All work performed in the Contract shall comply with all relevant codes adopted by the state and locality in which the project is located.

G. All 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.

H. The drawings are diagrammatic only. It is the responsibility of this Contractor to coordinate the installation of the specified components with all other trades to accomplish the following:

1. Allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. Provide for ease of disconnecting the equipment with minimum interference with other installations.

3. Allow right of way for piping and conduit installed at required slope.

4. So connecting raceways, cables, wireways, cable trays and busways will be clear of obstructions and of the working and access space of other equipment.

I. All work shall be installed in a neat and workman like manner complying with standards in NECA1, Standard for Good Workmanship in Electrical Construction.

1.2 WARRANTY

A. At a minimum the Contractor shall warranty all defects in material and labor for one year starting from the date of substantial completion. In the event of a multi-phased renovation, the warranties shall start on the date of substantial completion of the final

phase. Additional warranties may be required and will be described within the associated specification section.

1.3 SHOP DRAWINGS

A. The Contractor shall provide the Engineer with any and all product cutsheets, dimensioned drawings, wiring diagrams or any other documentation which may be required to describe the material to be provided as part of this Contract.

1.4 OPERATION AND MAINTENANCE MANUALS

A. Provide product information for all electrical components to be included in the operation and maintenance manuals. The information shall include at a minimum cutsheets for all equipment, requirements for routine maintenance and instructions for testing and adjusting equipment.

1.5 SMOKE AND FIREPROOFING

A. The Contractor shall provide fire and/or smoke stopping around/in any components which penetrate rated assemblies as required to maintain the rating of that assembly.

B. Refer to the related specifications under Division 07 for additional information.

1.6 TRENCHING AND BACKFILLING

A. All conduits located beyond the building perimeter must be buried a minimum of 30 inches below grade to the top of the conduit with the exception of conduits used for underground primary. Underground conduits used for primary electrical service shall be buried a minimum of 42 inches below grade unless otherwise noted.

B. Excavate utility trenches a minimum of 6 inches below the bottom of conduit and 6 inches on each side of the outer most conduit. When multiple conduits are installed within a common trench, 3 inches shall be maintained between the edges of all conduits. Install conduit spacers as required to maintain clearances between conduits.

C. Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduits. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

D. Place backfill on subgrades free of mud, frost, snow or ice. Install backfill as specified under Division 02.

E. Provide detectable warning tape above buried pipes and conduits. The warning tape shall be installed 12 inches below the top of grade except where located under pavements and slabs, and then it shall be buried 6 inches below subgrade. Install tape per manufacturers instructions.

F. Refer to the specifications under Division 02 for additional trenching and backfilling requirements.

END OF SECTION 260500

SECTION 260500.01 – PREVENTATIVE MAINTENANCE FOR ELECTRICAL EQUIPMENT

1.1 GENERAL

A. The General Conditions and Special Conditions and all other Contract Documents shall apply to this Division of the work as well as to all other Divisions.

1.2 SCOPE

A. This Section details the requirements for the Electrical Contractor to perform scheduled Preventative Maintenance (PM) on electrical systems for the first year of occupancy (starting at date of substantial completion), including the following electrical equipment:

1. Electrical Distribution Equipment
2. Emergency Generator
3. Fire Alarm System

B. All work for this project must comply and be in strict accordance with the Kentucky Building Code, National Electric Code, NFPA, ADA, NEC and all local codes and regulations. Maintenance procedures shall comply with the following:

1. NEMA PB1.1
2. ANSI/NETA MTS

C. Technician's performing the test and inspections shall be trained and experienced concerning the equipment and systems being evaluated. They shall be capable of conducting tests in a safe manner with knowledge of the hazards involved.

D. Preventative maintenance shall be performed to verify that equipment has been installed and continues to operate in strict accordance with manufacturer's requirements.

E. In addition to inspecting items as listed below, the Electrical Contractor shall correct any and all deficiencies found in accordance with the first year parts and labor warranty.

F. NOTE: A representative of LFUCG or the Fire Department must be made aware of PM activities a minimum of one (1) week prior to site visit by the contractor. And Owner's representative may accompany the contractor during the completion of work described herein.

1.3 DESCRIPTION OF SERVICES FOR SWITCHGEAR AND PANELBOARDS

A. At 6 months and 12 months following date of substantial completion, a thorough Preventative Maintenance schedule will be performed including the following:

1. Inspect physical, electrical and mechanical condition including signs of moisture or condensation
2. Inspect anchorage, alignment, grounding and working clearances
3. Clean the equipment. Remove dust and dirt with brush, vacuum cleaner or lint-free rag.
4. Exercise all active components. Operate all circuit breakers to insure smooth operation.
    a. Confirm adjustable device settings in accordance with project coordination study.

5. Check integrity of all electrical and mechanical interlocks and locking mechanisms.

6. Visually check all conductors and connections that they are clean and secure. Inspect bolted electrical connections for high resistance.

   a. Perform a thermographic survey. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

7. Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces

1.4 DESCRIPTION OF SERVICES FOR EMERGENCY GENERATOR

A. Refer to Specification Section 263213.3.7 for Maintenance Services required for Emergency Generator and Transfer Switches.

B. Inspection to include but not be limited to:

1. Inspect physical, electrical and mechanical condition.

2. Inspect anchorage, alignment, grounding and working clearances

3. Clean the equipment. Remove dust and dirt with brush, vacuum cleaner or lint-free rag.

4. Exercise all active components and overcurrent protection devices.

5. Functionally test engine shutdown for low oil pressure, overtemperature, overspeed and other protection features as applicable

6. Conduct performance test in accordance with ANSI.NFPA 110

1.5 DESCRIPTION OF SERVICES FOR FIRE ALARM SYSTEM

A. Refer to Specification Section 28311.3.6 for Maintenance Services required for Fire Alarm Systems.

1.6 SUBMITTALS

A. Provide a written report of completed work, operating log, and indicate any uncorrected or corrected deficiencies detected.

B. At date of substantial completion, provide Owner with a comprehensive Preventative Maintenance (PM) Schedule for the upcoming year for their review and acceptance. Contractor is responsible for notifying the Owner of upcoming service days and coordinate with the Owner's schedule as required.

END OF SECTION 238146.1

SECTION 260505 – PENETRATION FIRESTOPPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

1.2 SUBMITTALS

A. Product data for each type of product indicated.

B. Shop drawings detailing materials, installation methods, and relationships to adjoining construction for each through-penetration firestop system, and each kind of construction condition penetrated and kind of penetrating item.

1. Provide documentation from a qualified testing and inspecting agency indicating that each through-penetration firestop configuration submitted has been tested for the manner in which it is to be installed.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:

a. Classification markings on penetration firestopping correspond to designations listed by the following:

i) UL in its "Fire Resistance Directory."

ii) Intertek ETL SEMKO in its "Directory of Listed Building Products."

iii) FM Global in its "Building Materials Approval Guide."

C. Single-source responsibility: Obtain through-penetration fire-stop systems for each kind of penetration and construction condition from a single-supplier.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping

manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.5 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 3M

B. Dow Corning Corporation

C. Hilti Construction Chemicals

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.

2. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.

E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

H. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:
   a. Slag-wool-fiber or rock-wool-fiber insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board.
   d. Fillers for sealants.
2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-

retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.

2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIELD QUALITY CONTROL

A. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

B. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.5 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 260505

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 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.

1.2 SUBMITTALS

A. Product Data: For each conductor type.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Acceptable Manufacturers:

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and SO.

D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

A. Acceptable Manufacturers:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Conductors: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND WIRING METHODS

A. All locations unless otherwise noted: Conductors shall have THHN-THWN insulation and installed in raceway.

B. Branch Circuits Concealed in Ceilings, Walls and Partitions: Type THHN/THWN single conductors in raceway or type MC Metal-clad cable.

C. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

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. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 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 unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

END OF SECTION 260519

SECTION 260526 – GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment:

1.2 SUBMITTALS

A. Product Data: For the grounding bus.

1.3 QUALITY ASSURANCE

A. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Bare Grounding Conductor:

1. No. 4 AWG minimum, soft-drawn copper.

D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 4 inches in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, 3/4 inch diameter by 10 feet length.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.

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. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.

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.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. 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.

C. Signal and Communication Equipment: For telephone, fire alarm, voice and data, security and other communication/low voltage equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-16-inch grounding bus.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

D. Signal and communications pathways: Pathways include cable tray, conduits and sleeves. Any path that signal or communications cabling is routed.

1. Install metal conduit sleeves entering the communication rooms with grounding bushings and connect with grounding conductor to grounding system.

2. Ground cable trays according to manufacturer's written instructions.

3. Conduit stub-ups and stub-outs do not need to be grounded.

4. Test the pathway to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with the maximum grounding resistance. Adhere to the recommendations of the ANSI/TIA 607B standards. Install in accordance with best industry standards.

E. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 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.

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes shall be at least 12 inches 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.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in EMT conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to

main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

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.

F. 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.

G. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 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 grounding grid or to grounding electrode external to concrete.

3.4 FIELD QUALITY CONTROL

A. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

B. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

C. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.

1. 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.

2. Perform tests by fall-of-potential method according to IEEE 81.

D. Ground resistances shall not exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.

2. Power and Lighting Equipment or System with Capacity 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: 3 ohm(s).

E. If resistance to ground exceeds specified values, take appropriate measures to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. 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.

1.3 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.

1.4 SUBMITTALS

A. Seismic Qualification Certificates: For hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

B. Detailed description of equipment anchorage

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. Acceptable Manufacturers:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.

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 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. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

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

   a. Acceptable Manufacturers:

      1) Hilti Inc.

      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

      3) MKT Fastening, LLC.

      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

   a. Acceptable Manufacturers:

      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: Threaded steel.

G. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

2. Component Importance Factor: 1.5.

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 NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. 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.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.

5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4

inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

7. To Light Steel: Sheet metal screws.

8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both 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.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION 260529

SECTION 260533 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED 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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. LFMC: Liquidtight flexible metal conduit.

D. LFNC: Liquidtight flexible nonmetallic conduit.

E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.

2. For handholes and boxes for underground wiring, including the following:

a. Duct entry provisions, including locations and duct sizes.

b. Frame and cover design.

c. Grounding details.

d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

e. Joint details.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.

B. Rigid Galvanized Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. EMT: ANSI C80.3.

E. FMC: Zinc-coated steel or aluminum.

F. LFMC: Flexible steel conduit with PVC jacket.

G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel type.

H. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

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. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.

11. RACO; a Hubbell Company.

12. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. LFNC: UL 1660.

D. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

E. Fittings for LFNC: UL 514B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

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. Arnco Corporation.

2. Endot Industries Inc.

3. IPEX Inc.

4. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for plenum riser general-use installation as required by the environment.

2.4 METAL WIREWAYS

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

1. Cooper B-Line, Inc.

2. Hoffman.

3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include 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. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

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

a. Thomas & Betts Corporation.

b. Walker Systems, Inc.; Wiremold Company (The).

c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

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

a. Butler Manufacturing Company; Walker Division.

b. Hubbell Incorporated; Wiring Device-Kellems Division.

c. Panduit Corp.

d. Walker Systems, Inc.; Wiremold Company (The).

e. Wiremold Company (The); Electrical Sales Division.

2.6 BOXES, ENCLOSURES, AND CABINETS

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

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.

2. EGS/Appleton Electric.

3. Hoffman.

4. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.

5. RACO; a Hubbell Company.

6. Robroy Industries, Inc.; Enclosure Division.

7. Thomas & Betts Corporation.

8. Walker Systems, Inc.; Wiremold Company (The).

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.

F. Nonmetallic Floor Boxes: Nonadjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

J. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.

1. Color of Frame and Cover: Green.
2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC" or "TELEPHONE." as applicable each service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
    a. Armorcast Products Company.
    b. Carson Industries LLC.
    c. CDR Systems Corporation.
    d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
    a. Armorcast Products Company.
    b. Carson Industries LLC.

c. Christy Concrete Products.

d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of fiberglass.

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:

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

a. Carson Industries LLC.

b. Christy Concrete Products.

c. Nordic Fiberglass, Inc.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid Galvanized Steel Conduit (RSC)

2. Concealed Conduit, Aboveground: RNC, Type EPC-40-PVC.

3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment):LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

6. Application of Handholes and Boxes for Underground Wiring:

a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.

b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Heavy-duty fiberglass units with polymer-concrete frame and cover, SCTE 77, Tier 8 structural load rating.

c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed, Not Subject to Severe Physical Damage: EMT.

3. Exposed and Subject to Severe Physical Damage: RSC. Includes raceways in the following locations:

a. Loading dock.

b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

4. Above Ceilings: EMT.

5. Concealed within concrete block and concrete walls: RNC. RNC shall transition to EMT above ceiling and all boxes shall be steel. No non-metallic boxes shall be permitted.

6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.

7. Damp or Wet Locations: Rigid Steel Conduit.

8. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.

9. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.

10. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.

11. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

12. Exposed not Subject to Severe Damage, Below Ceiling, Finished Space: Surface Raceway

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

E. 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.

F. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

F. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

G. Surface Raceways: Coordinate installation with architectural drawings including windows, furniture, etc.

H. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Change from ENT to rigid steel conduit or EMT, as applicable, before rising above the floor.

4. Raceways shall not be embedded in slab on grade, bury with minimum 4" cover below slab.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches of slack at each end of pull wire.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.

2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet .

3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where otherwise required by NFPA 70.

N. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

P. Set metal floor boxes level and flush with finished floor surface.

Q. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in architectural and/or civil engineering specifications for pipe less than 6 inches in nominal diameter.

2. Install backfill as specified in architectural and/or civil engineering specifications.

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in architectural and/or civil engineering specifications.

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 26 05 36 – CABLE TRAYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes basket cable trays, ladder runway and accessories. The term "cable tray" is used interchangeably to describe either wire basket tray or ladder runway.

1.2 SUBMITTALS

A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated. Include data on all specified cable tray accessories.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain components through one source from a single manufacturer.

B. UL Classified as equipment grounding conductor.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Chalfant Manufacturing Company.
2. Cooper B-Line, Inc.
3. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
4. GS Metals Corp.; GLOBETRAY Products.
5. MONO-SYSTEMS, Inc.
6. MPHusky.
7. PW Industries.
8. Cablofil.
9. Southwest Data Products (Ladder Rack Only)
10. Chatsworth
11. Snake Tray

2.2 MATERIALS AND FINISHES

A. Cable Trays, Fittings, and Accessories: Pre-galvanized steel meeting the minimum mechanical properties of ASTM A641.

B. Ladder type runway, fittings and accessories: Flat black powder coat painted aluminum. Extruded aluminum shall be from Aluminum Association Alloy 6063. Fabricated parts shall be made from Aluminum Association Alloy 5052.

C. Sizes and Configurations:

1. Ladder runway shall be 18" inches wide with rungs 9" inches on center. Side rails shall be 2" inches tall.
2. Refer to the drawings for the basket type cable tray size.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Supports and connectors, including bonding jumpers, as recommended by manufacturer.

C. Manufacturer's metallic or non-metallic dropouts, cable rollers, non-metallic radius shields and rubber caps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ladder runway shall in installed within the communications closets. Basket type cable tray shall be installed at all other locations unless otherwise noted on the drawings.

B. Comply with recommendations in NEMA VE 2 and ANSI/EIA/TIA 569A. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

C. Remove burrs and sharp edges from cable trays.

D. Fasten cable tray supports to building structure.

1. Place supports so that spans do not exceed maximum spans per manufacturer.
2. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
3. Support bus assembly to prevent twisting from eccentric loading.
4. Locate and install supports according to NEMA VE 1.
5. Trays shall be supported using a minimum of ¼" inch all threaded rod when using trapeze hangers.

E. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

F. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA VE 1. Space connectors and set gaps according to applicable standard.

G. Make changes in direction and elevation using standard fittings.

H. Make cable tray connections using standard fittings.

I. Workspace: Install cable trays with enough space to permit access for installing cables.

J. Radius Shields: Install where cable tray changes direction.

K. Dropouts: Install where cable extends downward from tray.

L. Cable Rollers: Install at corners for ease of cable installation.

M. Rubber Caps: Install at exposed ends of wire basket tray.

3.2 CABLE INSTALLATION

A. Install cables only when cable tray installation has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or velcro cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. On vertical runs, fasten cables to tray every 18 inches. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

D. In existing construction, remove inactive or dead cables from cable tray.

3.3 CONNECTIONS

A. Ground and bond metal cable tray according to manufacturer's written instructions and NFPA 70, Article 392.

1. Provide continuity between cable tray components.

2. Make connections to tray using mechanical, compression or exothermic connectors.

3.4 FIELD QUALITY CONTROL

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:

1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.

2. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.

3. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.

4. Test cable tray to ensure electrical continuity of bonding and grounding connections. There shall be a continuous electrical path to the electrical grounding system from any point on the telecommunications pathway. See NFPA 70B, Chapter 18, for testing and test methods.

5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.

6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

B. Report results in writing.

3.5 PROTECTION

A. Protect installed cable trays.

1. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for

cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.

2. Provide protection from paint. Wrap cables in plastic, or other means to ensure cables do not get painted during construction.

END OF SECTION 26 05 36

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

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 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.

2. Legend: Indicate voltage.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,.

2.6 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."

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a black background. Minimum letter height shall be 3/8 inch.

2.8 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. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

H. 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.

I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. 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.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

b. Colors for 208/120-V Circuits:

i) Phase A: Black.

ii) Phase B: Red.

iii) Phase C: Blue.

c. Colors for 480/277-V Circuits:

i) Phase A: Brown.

ii) Phase B: Orange.

iii) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

D. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

E. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

F. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. 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.

b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

c. 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.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.

b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.

d. Switchgear.

e. Switchboards.

f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

g. Emergency system boxes and enclosures.

h. Motor-control centers.

i. Enclosed switches.

j. Enclosed circuit breakers.

k. Enclosed controllers.

l. Variable-speed controllers.

m. Push-button stations.

n. Power transfer equipment.

o. Contactors.

p. Remote-controlled switches, dimmer modules, and control devices.

q. Battery-inverter units.

r. Battery racks.

s. Power-generating units.

t. Monitoring and control equipment.

u. UPS equipment.

END OF SECTION 260553

SECTION 260573 – SHORT CIRCUIT AND PROTECTIVE COORDINATION STUDIES

PART 1 - GENERAL

1.1 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies for the emergency system.

B. The scope of the studies shall include all electrical distribution equipment that is part of the emergency system. Also include the normal system distribution equipment that is located upstream of the emergency system. The service equipment shall be labeled with the maximum available fault current.

1.2 SUBMITTALS

A. The studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the study may cause delays in equipment shipments, approval from the Engineer may be obtained for a preliminary submittal of data to ensure that the selection of device ratings and characteristics will be satisfactory to properly select the distribution equipment. The formal study will be provided to verify preliminary findings.

B. The results of the short-circuit and protective device coordination studies shall be summarized in a final report. Electronic PDF copies of the report shall be provided. A minimum of one (1) bound printed copy shall be submitted to the Engineer for review and one (1) bound and printed copy shall be included in the operations and maintenance manuals.

C. The report shall include the following sections:

1. Executive Summary including Introduction, Scope of Work and Results/Recommendations.
2. Short-Circuit Methodology Analysis Results and Recommendations
3. Short-Circuit Device Evaluation Table
4. Protective Device Coordination Methodology Analysis Results and Recommendations
5. Protective Device Settings Table
6. Time-Current Coordination Graphs and Recommendations
7. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

1.3 QUALIFICATIONS

A. The short-circuit and protective device coordination studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer, licensed in the state of Kentucky, skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be an employee of the equipment manufacturer or an approved engineering firm.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. Computer Analysis Software

1. The studies shall be performed using SKM Systems Analysis Power*Tools for Windows (PTW) software program, or an approved equivalent software.

PART 2 - PRODUCT

2.1 STUDIES

A. The contractor shall furnish short-circuit and protective device coordination studies for the emergency system, including normal side distribution equipment located upstream of the emergency system. The main service equipment shall be labeled with the maximum available fault current.

2.2 DATA

A. Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit and protective device coordination studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from the Contract Documents.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT ANALYSIS

A. Transformer design impedances shall be used when test impedances are not available.

B. Provide the following:

1. Calculation methods and assumptions

2. Selected base per unit quantities

3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis

4. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.

5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.

6. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

C. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.

D. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings

2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses

3. Contractor shall notify the Engineer in writing, of any circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS

A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title with descriptive device names.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility's overcurrent protective device

2. Medium voltage equipment overcurrent relays

3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands

4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands

5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves

6. Medium voltage conductor damage curves

7. Ground fault protective devices, as applicable

8. Pertinent motor starting characteristics and motor damage points, where applicable

9. Pertinent generator short-circuit decrement curve and generator damage point

10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. Provide the following:

1. A One-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.

2. 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.

3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

4. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram

5. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

6. Contractor shall notify the Engineer in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.

B. Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Contractor shall notify the Engineer in writing of any required major equipment modifications.

3.2 LABELS

A. The Contractor shall label the normal system service equipment with the maximum available fault current. The label(s) shall include the date the fault current calculation was performed.

END OF SECTION 260573

SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Owner's Project Requirements and Systems Basis of Design documentation are included by reference.

C. Commissioning Plan and Appendices.

1.02 SUMMARY

A. Section includes commissioning process requirements for Electrical Systems, assemblies, and equipment.

B. Related Sections:

1. Section 017900 – Demonstration and Training
2. Section 019113 - General Commissioning Requirements
3. Section 019113.13 – Functional Testing
4. Division 26 Sections for electrical equipment and assemblies.

1.03 SYSTEMS COMMISSIONED

A. Equipment List
1. Emergency Generator
2. Lighting Controls
3. Lighting Fixtures

1.04 CONTRACTOR'S RESPONSIBILITIES

A. Attend Construction Phase Commissioning Conference.

B. Satisfy applicable project Owner's Project Requirements.

C. Review the Commissioning Plan prepared by Commissioning Authority.

D. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.

E. Cooperate with the Commissioning Authority for resolution of issues recorded in the Issues Tracking Log. Resolution will occur within one week of finding and notification.

F. Attend Commissioning Team Meetings held on a bi-weekly basis.

G. Integrate and coordinate commissioning process activities with Construction Schedule.

H. Review, accept, and support execution of Construction Checklists provided by the Commissioning Authority.

I. Support completion of Construction Checklists as Work is completed.

J. Review and accept Functional Test Procedures provided by the Commissioning Authority.

K. Support completion of Functional Test Procedures, including seasonal and any deferred test procedures.

L. Provide Owner training as directed in equipment specification sections and Section 017900.

M. Provide O&M Manuals as required by the A/E.

N. Provide project specific close-out documents as required for the systems manual per LEED EAc3: Enhanced Commissioning.

O. Provide access to electrical, water, scaffolding, man-lifts, of other mechanical conveyances used by the contractors to perform their work during functional and performance testing under the direction of the CA. If mechanical conveyances are unavailable during the commissioning process, the Construction Manager will provide the necessary equipment for access required.

1.05 COMMISSIONING AUTHORITY'S RESPONSIBILITIES

A. See specification section 019113, 1.07 'Commissioning Authority's Responsibilities'

1.06 LIGHTING CONTROL CONTRACTOR'S RESPONSIBILITIES

A. Due to the impact the Lighting Controls System has on the success of functional testing, the following supplemental requirements shall apply.

B. Project specific responsibilities of Lighting Controls Contractor:

1. Provide a written plan to the Commissioning Authority and Architect / Engineer describing process for completing checkout and start-up of Lighting Controls System.
2. Provide resources to facilitate Functional Testing of Lighting and Daylighting Systems, assemblies, equipment, and components including but not limited to technicians, any necessary unique instruments for verifying photometric readings, and passwords for lighting control system interfaces.

1.07 COMMISSIONING SUBMITTALS

A. Equipment submittals for commissioned systems, assemblies, equipment, and components will be reviewed by the Commissioning Authority as part of the normal submission procedure.

B. All testing plans and schedules to be reviewed and approved by Commissioning Authority as indicated in this Section and the Commissioning Plan.

1. Lighting Controls System Point-to-Point Check
2. Grounding Study
3. Conductivity Test Results

1.08 COMMISSIONING DOCUMENTATION

A. Contractor shall provide the following information to the Commissioning Authority during the commissioning process for inclusion in the Commissioning Plan:

1. Process and schedule for Supporting Completion of Construction Checklists for Electrical Systems, assemblies, equipment, and components to be verified and tested.
2. Support Completion of Construction Checklists for review and approval by Commissioning Authority and Architect / Engineer.

B. In addition to the requirements detailed in applicable Division 26 sections, the Contractor shall provide the following information, in electronic form, to the Architect / Engineer for inclusion in the Commissioning Report:

1. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
2. Test and inspection reports and certificates.
3. Completed Functional Test procedures.
4. Response to corrective action documents.
5. A record of Owner training sessions.

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.01 CONSTRUCTION CHECKLISTS PREPARATION

A. Refer to Section 019113 - General Commissioning Requirements for complete procedures and requirements.

3.02 CONSTRUCTION CHECKLISTS EXECUTION

A. Refer to Section 019113 - General Commissioning Requirements for complete procedures and requirements.

3.03 FUNCTIONAL TEST PREPARATION

A. Refer to Section 019113.13 – Functional Testing for complete procedures and requirements.

3.04 GENERAL FUNCTIONAL TESTING REQUIREMENTS

A. Refer to Section 019113.13 – Functional Testing for complete procedures and requirements.

3.05 FUNCTIONAL TEST EXECUTION

A. Refer to Section 019113.13 – Functional Testing for description of tasks to complete for this project.

3.06 POST ACCEPTANCE PERIOD

A. Refer to Section 019113.13 – Functional Testing for complete seasonal or deferred testing procedures and requirements.

3.07 OWNER TRAINING

A. Refer to Section 017900 – Demonstration and Training for Owner Training requirements for this project.

END OF SECTION 260800

SECTION 260923 – LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. SUMMARY

B. The lighting control system specified in this section shall provide time-based, sensor-based and manual lighting control. All system devices shall be networked together enabling digital communication and shall be individually addressable.

C. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity even if network connectivity to the greater system is lost.

D. The system architecture shall facilitate remote operation via a computer connection.

E. System shall accept dry contact closure input from Station Alerting System for activation of lighting in selected rooms or control zones by the Alerting System.

1.2 SHOP DRAWINGS

A. Product Datasheets for all lighting control components.

B. Riser Diagrams – detailed drawings showing interconnectivity of devices. Provide a riser diagram for each zone.

C. Drawings showing the location and type of each device overlaid on the floor plan. Show all interconnections between devices. This drawings shall be representative of the graphical user interface (GUI) provided with the control software.

D. Example Contractor Startup/Commissioning Worksheet

1.3 OPERATION AND MAINTENANCE MANUALS

A. Include Hardware and Software Operation Manuals.

B. A list/description of any routine maintenance requirements.

C. Provide a typed description of the final control sequence for each lighting zone.

1.4 QUALITY ASSURANCE

A. All components and the manufacturing facility where product was manufactured must be ROHS compliant.

B. When LCS components are installed in high humidity or cold environments, they shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.

C. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

1.5 COORDINATION

A. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

1.6 WARRANTY

A. All devices in lighting control system shall have a 5 year warranty starting from the date of substantial completion. The first year's warranty shall include materials and labor. The remainder of the term of the warranty shall include material only.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of design: nLight Network Control System or equivalent by WattStopper DLM System, or Lutron Lighting Controls.

2.2 SYSTEM REQUIREMENTS

A. Refer to the drawings for additional information and riser diagrams.

B. System shall have an architecture that is based upon three main concepts: 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.

C. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.

D. Intelligent lighting control devices shall communicate digitally, require <4 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.

E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.

F. Devices within a lighting control zone shall be connected with CAT-5 low voltage cabling in any order.

G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.

H. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.

I. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone "bus power supplies" shall not be required in all cases.

J. System shall have one or more primary wall mounted network control "gateway" devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.

K. System shall use "bridge" devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.

L. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.

M. Individual lighting zones shall be capable of being segmented into several "local" channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.

N. Devices located in different lighting zones shall be able to communicate occupancy, photocell, and switch information via wired backbone.

O. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a space's sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space.

P. An application that runs on "smart" handheld devices (such as an Apple® IPhone®) shall be available for personal lighting control.

Q. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.

R. Control software shall be capable of integration with the BMS via BACnet IP.

2.3 INDIVIDUAL DEVICE SPECIFICATIONS

A. Control Module (Gateway)

1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet.

2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.

3. Control device shall have three RJ-45 ports for connection to other backbone devices (bridges) or directly to lighting control devices.

4. Device shall automatically detect all devices downstream of it.

5. Device shall have a standard and astronomical internal time clock.

6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.

7. Device shall have a USB port

8. Each control gateway device shall be capable of linking 1500 devices to the management software.

9. Device shall be capable of using a dedicated or DHCP assigned IP address.

B. Networked System Occupancy Sensors

1. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

2. Passive Infrared Sensors (PIR) shall utilize passive infrared technology, which detects occupant motion. Ultrasonic or Microwave based sensing technologies shall not be accepted.

3. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.

4. All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.

5. Sensors shall be available with zero, one, or two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 / 277 / 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor. Relays shall be dry contacts.

6. Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.

7. Sensors shall be available in multiple lens options which are customized for specific applications.

8. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

9. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.

10. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue

11. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.

12. Fixture mount sensors shall be capable of powering themselves via a line power feed.

13. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.

14. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).

C. Networked System Daylight (Photocell and or Dimming) Sensors

1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.

2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.

3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

4. Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of class 2 current (typically 40 or more ballasts).

5. Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)

6. Combination units that have all features of on/off photocell and dimming sensors shall also be available.

7. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.

8. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC, 277 VAC, and 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load. Relays shall be dry contacts.

9. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.

D. Networked System Power (Relay) Packs

1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.

2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.

3. All devices shall have two RJ-45 ports.

4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.

5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.

6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.

7. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all lighting load types.

8. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).

9. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
10. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
11. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
12. Specific Secondary Packs shall be available that control louver/damper motors for skylights.
13. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
14. Secondary Power Packs shall be available listed for 20A plug load control.

E. Networked System Relay & Dimming Panels

1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
3. Panel shall provide one 0-10VDC dimming output paired with each relay.
4. Panel shall power itself from an integrated 120/277 VAC supply.
5. Panel shall be capable of operating as either two networked devices or as one.
6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection

F. Networked Auxiliary Input / Output (I/O) Devices

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
2. Devices shall have two RJ-45 ports
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).
5. Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.
6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output
7. Specific I/O devices shall sense state of low voltage outdoor photocells
8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.

G. Networked System Wall Switches & Dimmers

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Devices shall be available with zero or one integrated Class 1 switching relay.
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. All sensors shall have two RJ-45 ports.
5. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
6. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
7. Devices with dimming control outputs can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of current (typically 40 or more ballasts).
8. Devices with capacitive touch buttons shall provide audible user feedback with different sounds for on/off, raise/lower, start-up, and communication offline.
9. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
10. Devices with mechanical push-buttons shall be made available with custom button labeling
11. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.

H. Networked System Graphic Wall Station

1. Device shall have a 3.5" full color touch screen for selecting up to 8 programmable lighting control presets or acting as up to 16 on/off/dim control switches.
2. Device shall enable configuration of lighting presets, switched, and dimmers via password protected setup screens.
3. Device shall enable user supplied .jpg screen saver image to be uploaded.
4. Device shall surface mount to single-gang switch box
5. Device shall have a micro-USB style connector for local computer connectivity.
6. Device shall have two RJ-45 ports for communication

I. Networked System Scene Controllers

1. Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.
2. Device shall recess into single-gang switch box and fit a standard GFI opening.
3. Devices shall provide LED user feedback.
4. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
5. All sensors shall have two RJ-45 ports.

6. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.

7. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).

8. Device shall have LEDs indicating current selection.

J. Communication Bridges

1. Device shall surface mount to a standard 4" x 4" square junction box.

2. Device shall have 8 RJ-45 ports.

3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.

4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.

5. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

2.4 LIGHTING CONTROL PROFILES

A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.

D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

E. All lighting control profiles shall be stored on the network control gateway device and on the software's host server.

F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

H. Daylight savings time adjustments shall be capable of being performed automatically.

I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

2.5 MANAGEMENT SOFTWARE

A. Software shall provide a graphical tool for easily viewing and scheduling lighting control profiles.

B. The software shall have a graphical user interface (GUI) with each lighting component shown overlayed on an electronic floor plan (AutoCAD floor plan or equivalent).

C. The GUI shall be interactive. The end user shall be able to simply point and click on any device to review the status of devices and change settings and profiles.

D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software

E. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

F. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

G. A printable network inventory report shall be available via the software.

H. A printable report detailing all system profiles shall be available via the software.

I. Software shall require all users to login with a User Name and Password.

J. Software shall provide at least three permission levels for users.

K. All sensitive stored information and privileged communication by the software shall be encrypted.

L. All device firmware and system software updates must be available for automatic download and installation via the internet.

M. Software shall be capable of managing systems interconnected via a WAN (wide area network)

N. The management software shall be SensorView or equivalent.

O. Computer Workstation

1. Provide desktop computer workstation for management software installation complete with 17" LED monitor, keyboard and pointing device; minimum PC requirements: Intel Core I5, 4gb ram, 250gb hard drive, and Windows 8 operating system.

2.6 BMS COMPATIBILITY

A. Provide the ability for the LCS to interface with the BMS. Provide a BACnet interface.

B. The LCS shall interface with BAS to allow the BMS to program Time-of-Day schedules.

C. The BACnet interface is for potential future integration to the BMS and the LCS is not required to be integrated as part of this project.

2.7 SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.

B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.

C. An "Energy Scorecard" shall be display that shows calculated energy savings in dollars, KWHr, or CO2.

D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).

E. Energy savings data shall be calculated for the system as a whole or for individual zones.

F. A time scaled graph showing all relay transitions shall be presented.

G. A time scaled graph showing a zones occupancy time delay shall be presented

H. A time scaled graph showing the total light level shall be presented.

I. User shall be able to customize the baseline run-time hours for a space.

J. User shall be able to customize up to four time-of-day billing rates and schedules.

K. Data shall be made available via a .CSV file

2.8 START-UP & SUPPORT FEATURES

A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.

B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.

C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.

D. All system devices shall be capable of being given user defined names.

E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

F. All sensor devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The control system shall be installed and wired as shown on the plans, as described within this specification and according to the manufacturer's recommendations.

B. A factory trained technician shall provide on-site commissioning, start-up and owner training. The owner training will only happen after the system has been commissioned and fully programmed and proven to be operating. This includes the ability to remotely operate the system via the Ethernet. The technician shall inform the Engineer when the system is completely operational so the Engineer can conduct an inspection prior to the owner training. The technician shall be present during the Engineer's inspection. The owner's training and Engineer's inspection will not occur on the same day. Provide

minimum of two separate training sessions for the Owner of 4 hours each; one scheduled before and one after building occupancy.

C. Provide computer workstation as specified and install the management software. Coordinate location with Owner. Provide communication outlet at computer with connection to building network.

D. Coordinate with the Owner's Technology Coordinator for required IP addresses.

E. The LCS manufacturer's technician shall schedule and provide the following at a minimum:

1. Pre-installation meeting with electrical contractor.
2. Start-up and commissioning.
3. Owner Training.

3.2 COMMISSIONING

A. A third party commissioning service provider will be procured outside this contract to provide functional testing of the lighting control system.

B. The commissioning authority will review the system in accordance with the International Energy Conservation Code requirements.

C. The commissioning authority will provide the following at a minimum:

1. Ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's installation instruction.
2. Confirm that the placement, sensitivity and time-out adjustments for occupant sensors are meet the design requirements.
3. Confirm that the time switches and programmable schedule controls are programmed to turn the lights off at times determined by the owner.
4. Confirm that the placement and sensitivity adjustments for photosensor controls reduce the electric light based on the amount of usable daylight in the space as specified.

D. Electrical Contractor's Responsibilities

1. Attend commissioning meetings as scheduled by the Commissioning Authority.
2. Verify proper installation and performance of all electrical services provided.
3. Complete system verification checklists and manufacturer's prestart checklists prior to scheduling start-up of commissioned equipment.
4. Monitor and respond to Resolution Tracking Forms distributed by the Commissioning Authority in order to expedite corrective actions necessary to achieve the design intent.
5. Provide an electrical technician to assist during verification and performance testing.
6. Correct any issues that may be discovered during start-up and verification and performance testing.

3.3 SEQUENCES OF OPERATION

A. Refer to the drawings for additional information.

B. The time delay of all occupancy sensors shall be set to 30 minutes unless otherwise noted. Sensors in storage closets and individual restroom stalls shall be 5 minutes.

C. All lighting zones that contain occupancy sensors shall be set to manual on/auto off with the exception of stairwells or as otherwise noted on Drawings

D. Interior lighting zones controlled by a Time-of-Day schedule shall provide a "blink" of the lights to warn the occupants the lights are going to be swept off. The occupants shall have override capability. Once the warning has occurred, the occupant may override the lights on for up to 90 minutes. The override time shall be adjustable. The occupant shall be able to override the lights on for the designated amount of time by using the local switch. Prior to the lights being turned off after the allotted override time, the occupant shall be warned again. The process shall continue to repeat as described.

E. Specific times for Time-of-Day schedules will be determined by the owner during construction.

3.4 DOCUMENTATION

A. The contractor shall provide accurate as-built drawings to the Engineer for review. The as-builts at a minimum shall show the location of all LCS components. Where loads are connected to a relay panel, the as-builts shall indicate the load/zones controlled by each relay, electrical circuit number connected to each relay, and the relay panel number.

B. Provide a typed description of the final control sequence for each lighting zone. This shall be included in the Operation and Maintenance manuals.

3.5 FACTORY SUPPORT AND SERVICE

A. Factory telephone service support and assistance shall be available at no cost to the owner. It shall consist of solving programming or application questions concerning all components of the LCS.

END OF SECTION 260923

SECTION 262413 – SWITCHBOARDS

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. Service and distribution switchboards rated 600 V and less.
2. Transient voltage suppression devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

1.3 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

C. Seismic Qualification Certificates: For switchboards, overcurrent protective devices, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items.

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 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.6 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards 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.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F.

b. Altitude: Not exceeding 6600 feet.

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

D. 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 Architect and Owner no fewer than seven days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Architect's and Owner's written permission.

4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switchboards 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 in Division 03.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Panel or fixed, individually mounted.

2. Branch Devices: Panel mounted.

3. Sections front and rear aligned.

C. Nominal System Voltage: 480Y/277 V or 208Y/120 V as indicated on the Contract Documents.

D. Main-Bus Continuous: As indicated on the Contract Documents.

E. Indoor Enclosures: Steel, NEMA 250, Type 1.

F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

G. Where overcurrent devices are mounted on both sides of a central walk-in corridor, more than one thermostat may be required.

H. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

I. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

J. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with copper feeder circuit-breaker line connections.

2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

3. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

K. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

L. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.

2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
10. Four-digit, transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.

D. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec.surges with less than 5 percent change in clamping voltage.

E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 and 208Y/120 V, three-phase, four-wire circuits shall be as follows:

1. Line to Neutral: 800 V for 480Y/277 and 400 V for 208Y/120.
2. Line to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.
3. Neutral to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.

F. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

G. Protection modes and UL 1449 SVR for 240 or 480-V, three-phase, three-wire, delta circuits shall be as follows:

1. Line to Line: 2000 V for 480 V and 1000 V for 240 V.
2. Line to Ground: 1500 V for 480 V and 800 V for 240 V.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. 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 material.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

2.4 INSTRUMENTATION

A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
      a. Phase Currents, Each Phase: Plus or minus 1 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      d. Kilowatts: Plus or minus 2 percent.
      e. Kilovars: Plus or minus 2 percent.
      f. Power Factor: Plus or minus 2 percent.
      g. Frequency: Plus or minus 0.5 percent.
      h. Accumulated Energy, Kilowatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.

i. Kilowatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.

j. Contact devices to operate remote impulse-totalizing demand meter.

2. Ethernet communication: 10/100 Base-T UTP port. Full-function embedded web server providing standard web browser access to meter data and the ability to email on an alarm.

3. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.5 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards 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 switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, 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 switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Basic Electrical Materials and Methods."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Basic Electrical Materials and Methods."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Basic Electrical Materials and Methods."

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. 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.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

D. 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.

E. Switchboard will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

SECTION 262416 – PANELBOARDS

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Electronic-grade panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

C. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. 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.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. 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.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.

b. Altitude: Not exceeding 6600 feet .

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

1.8 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 in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Locations: NEMA 250, Type 1.

b. Outdoor Locations: NEMA 250, Type 3R.

c. Kitchen Areas: NEMA 250, Type 1, stainless steel trim.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

4. Finishes:

   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

   b. Back Boxes: Galvanized steel.

5. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Main and Neutral Lugs: Mechanical type.

3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

H. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.2 DISTRIBUTION PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt on circuit breakers.

F. 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. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only as indicated on the drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 ELECTRONIC-GRADE PANELBOARDS

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

1. Current Technology; a subsidiary of Danahar Corporation.

2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

4. Liebert Corporation.

5. Siemens Energy & Automation, Inc.

6. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1; with factory-installed, integral TVSS; labeled by an NRTL for compliance with UL 67 after installing TVSS.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

F. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.

G. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules)type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

1. Accessories:

a. Fuses rated at 200-kA interrupting capacity.

b. Fabrication using bolted compression lugs for internal wiring.

c. Integral disconnect switch.

d. Redundant suppression circuits.

e. Redundant replaceable modules.

f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

g. LED indicator lights for power and protection status.

h. Audible alarm, with silencing switch, to indicate when protection has failed.

i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

j. Four-digit, transient-event counter set to totalize transient surges.

2. Peak Single-Impulse Surge Current Rating: 160 kA per phase.

3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.

a. Line to Neutral: 70,000 A.

b. Line to Ground: 70,000 A.

c. Neutral to Ground: 50,000 A.

4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

5. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120 - V, three-phase, four-wire circuits shall be as follows:

a. Line to Neutral: 400 V for 208Y/120.

b. Line to Ground: 400 V for 208Y/120.

c. Neutral to Ground: 400 V for 208Y/120.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

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. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Mount top of trim 72 inches above finished floor unless otherwise indicated.

D. 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.

E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. 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.

B. Panelboards will be considered defective if they do not pass tests and inspections.

C. 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 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 indicated.

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 262416

SECTION 262726 – WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Wall-box motion sensors.
4. Snap switches and wall-box dimmers.
5. Solid-state fan speed controls.
6. Wall-switch and exterior occupancy sensors.
7. Cord and plug sets.
8. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

B. Related Sections include the following:

1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

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 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

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. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Receptacles shall have nickel-plated brass strap and a one piece strap with integral ground.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 5351 (single), 5352 (duplex).
   b. Hubbell; HBL5351 (single), CR5352 (duplex).
   c. Leviton; 5891 (single), 5352 (duplex).
   d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, safe lock protection, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Cooper; GF20.
   b. Pass & Seymour; 2084.

2.4 TAMPER-RESISTANT RECEPTACLES

A. 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.

1. Products: Subject to compliance with requirements products that may be incorporated into the Work include, but are not limited to, the following:
   a. Cooper; TR8300.
   b. Hubbell; HBL8300SGA.

c. Leviton; 8300-SGG.

d. Pass & Seymour; TR63H.

2.5 WEATHER-RESISTANT RECEPTACLES

A. Convenience Receptacles: 125 V, 20 A; Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper; WRBR20

b. Hubbell; BR20WR.

c. Leviton; WBR20.

d. Pass & Seymour; WR20TRW.

2.6 PLUG LOAD CONTROL RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Receptacle shall be marked to indicate that it is part of plug load control in accordance with the current version of the National Electrical Code. Receptacles shall have nickel-plated brass strap and a one piece strap with integral ground.

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

a. Leviton; 5362 (duplex).

b. Pass & Seymour; 26352 (duplex).

c. Cooper

d. Hubbell

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.

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

a. Cooper; L520R.

b. Hubbell; HBL2310.

c. Leviton; 2310.

d. Pass & Seymour; L520-R.

2.8 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.

2. 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: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.10 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

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

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).

b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).

c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).

d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

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

a. Cooper; 2221PL for 120 V and 277 V.

b. Hubbell; HPL1221PL for 120 V and 277 V.

c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.

d. Pass & Seymour; PS20AC1-PLR for 120 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

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

a. Cooper; 2221L.

b. Hubbell; HBL1221L.

c. Leviton; 1221-2L.

d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors

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

a. Cooper; 1995.

b. Hubbell; HBL1557.

c. Leviton; 1257.

d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

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

a. Cooper; 1995L.

b. Hubbell; HBL1557L.

c. Leviton; 1257L.

d. Pass & Seymour; 1251L.

2.11 OCCUPANCY SENSORS

A. Ceiling/Wall Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Watt Stopper (The);

b. Sensor Switch.

c. Hubbell.

2.12 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Kitchens: Stainless steel.

3. Material for Finished Spaces: Stainless Steel.

4. Material for Unfinished Spaces: Stainless Steel.

5. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, "While In Use" die-cast aluminum with lockable cover.

2.13 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.

2. Wiring Devices Connected to Emergency Power System: Red .

3. TVSS Devices: As selected by Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the 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.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.

b. Straighten conductors that remain and remove corrosion and foreign matter.

c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. 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.

G. Dimmers:

1. Install dimmers within terms of their listing.
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 manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. 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 not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.

4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Shunt trip switches.
4. Molded-case circuit breakers (MCCBs).
5. Molded-case switches.
6. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Manufacturer's field service report.

D. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items.

C. 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.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

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 Architect and Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Architect's and Owner's written permission.
4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 230 or 600V ac as indicated, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. 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.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I2t response.

F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

G. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

H. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel .
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 3R.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Label each enclosure with engraved metal or laminated-plastic nameplate.

END OF SECTION 262816

SECTION 262913 – ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage manual.
2. Full-voltage magnetic.
3. Reduced-voltage magnetic.
4. Reduced-voltage solid state.
5. Multispeed.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

G. SCR: Silicon-controlled rectifier.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and installed components.
2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
3. Manufacturer's written instructions for setting field-adjustable overload relays.
4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.

2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

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

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

c. Rockwell Automation, Inc.; Allen-Bradley brand.

d. Siemens Energy & Automation, Inc.

e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.

3. Surface mounting.

4. Red pilot light.

C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

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

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

c. Rockwell Automation, Inc.; Allen-Bradley brand.

d. Siemens Energy & Automation, Inc.

e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.

3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; melting alloy type.

4. Surface mounting.

5. Red pilot light.

D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

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

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

c. Rockwell Automation, Inc.; Allen-Bradley brand.

d. Siemens Energy & Automation, Inc.

e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.

3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button melting alloy type.

4. Surface mounting.

5. Red pilot light.

E. Magnetic Controllers: Full voltage, across the line, electrically held.

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

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

c. Rockwell Automation, Inc.; Allen-Bradley brand.

d. Siemens Energy & Automation, Inc.

e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.

3. Contactor Coils: Pressure-encapsulated type.

a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: Voltage as required by mechanical equipment; obtained from integral CPT, with primary and secondary fuses with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

a. CPT Spare Capacity: 50 VA.

6. Melting Alloy Overload Relays:

a. Inverse-time-current characteristic.

b. Class 10 tripping characteristic.

c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

7. External overload reset push button.

F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

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

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

c. Rockwell Automation, Inc.; Allen-Bradley brand.

d. Siemens Energy & Automation, Inc.

e. Square D; a brand of Schneider Electric.

2. Fusible Disconnecting Means:

a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.

b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

2.2 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.

2. Outdoor Locations: Type 3R.

3. Other Wet or Damp Indoor Locations: Type 4.

4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.3 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty type.

a. Push Buttons: Recessed types; maintained as indicated.

b. Pilot Lights: LED types; colors as indicated.

c. Selector Switches: Rotary type.

B. N.C. and N.O. auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

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

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding

racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "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 the full perimeter of concrete base.

2. For supported equipment, 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 supported equipment.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch enclosed controller.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

F. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved nameplate.

3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation.

2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.

3. Test continuity of each circuit.

4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).

5. Test each motor for proper phase rotation.

6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. Enclosed controllers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262913

SECTION 263213 – GENERATOR AND TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged diesel engine-generator set for Standby power supply and automatic transfer switches.

1.2 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over a range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. LP: Liquid Petroleum.

C. NG: Natural Gas.

D. Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of the power outage.

1.3 SUBMITTALS

A. Product Data: For each type of packaged engine generator and automatic transfer switch indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal Damage curve for generator.
2. Time-current characteristic of curves for generator protective device.
3. Fuel consumption in (gallons per hour OR cubic feet per hour) at .8 power factor at .5, .75 and 1.0 times generator capacity.

B. Shop Drawings: Detailed equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawing of engine-generator set and other components specified.
2. Wiring Diagrams: Power, signal, and control wiring.

1.4 PERMITS

A. The contractor shall obtain and pay for all required permits. This shall include, but not limited to, the permit application to install emergency power stand-by power systems from the Division of Fire Prevention – Hazardous materials section (fuel tank permit) and air permits from the Division for Air Quality.

1.5 QUALIFICATIONS

A. Qualification Data

1. The generator and transfer switch(es) shall be manufactured by an entity who has been regularly engaged in the production of engine-generator sets and associated controls for a minimum of twenty years, thereby identifying one source of supply and responsibility.

2. The manufacturer shall provide factory-trained service and parts support through a factory authorized dealer/supplier that is regularly doing business in the area of installation.

3. The manufacturer shall have printed literature and brochures describing the standard system specified, not a one of a kind fabrication.

4. As part of qualification process; an authorized dealer/supplier, herein known as the dealer shall represent the manufacturer. To qualify as the dealer/supplier, it must be a "Full Product Line Sales and Service Dealer and shall have 24-hour service availability. The dealer/supplier must have certified generator service technicians, inventory of parts to support after sales service and can prove 5 years of experience in the engine-generator field.

B. Seismic Qualification Certificates: For transfer switches, engine-generator set, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails identify center of gravity and total weight, including full fuel tank, supplied enclosure and each piece of equipment not integral to the engine-generator set, and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control test reports.

1. Certified summary of prototype-unit test report.

2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

4. Report of sound generation.

5. Report of exhaust emissions showing compliance with applicable regulations.

6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control test reports

E. Warranty: Special warranty specified in this Section

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine-generator sets and transfer switch(es) to include in emergency, operation, and maintenance manuals. Include the following:

1. List of tools and replacement items recommended to be stored at the Project for ready access. Including part and drawing numbers, and source of supply.

2. List of items requiring routine maintenance and recommended maintenance schedules.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than six (6) hours normal travel time from Installer's place of business to Project site.

B. Source Limitations: Obtain packaged engine-generator sets, transfer switch(es) and auxiliary components through one source from a single manufacturer.

C. Comply with ASME B15.1.

D. Comply with NFPA 37.

E. Comply with NFPA 30.

F. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

G. Comply with UL 2200.

H. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Minimum Temperature: 0 °F

2. Maximum Temperature: 100 °F

3. Relative Humidity: 0 - 95 percent

4. Altitude: 1000 feet

1.9 COORDINATION

A. Coordinate size and location of concrete bases for package engine-generator sets. Cast anchor-bolt inters into bases. Install concrete, reinforcement, and formwork in accordance with manufacturer's recommendations.

1.10 WARRANTY

A. First Year Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine-generator sets, automatic transfer switch(es) and associated auxiliary components that fail in materials or workmanship for one year from date of substantial completion. The warranty shall include parts and labor.

1. Extended Warranty: Starting from one year after the date of substantial completion and extending for one year, the manufacturer agrees to repair or replace components of the packaged engine generator sets, automatic transfer switch(es) and associated components that fail in material or workmanship. The warranty shall include parts and labor (mileage and travel time is excluded).

1.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide one year full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under

load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. MTU Onsite Energy.
2. Caterpillar; Engine Div.
3. Onan/Cummins Power Generation; Industrial Business Group.
4. Generac
5. Kohler

2.2 ENGINE-GENERATOR SET

A. 600 Volt 3 Phase 4w 60Hz diesel packaged engine generator set shall be a coordinated assembly of compatible components; Refer to Drawings for KW ratings and other requirements.

B. Factory-assembled and -tested, engine-generator set.

C. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

D. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidence by records of prototype testing.
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

E. Generator-Set Performance with permanent magnet excitation:

1. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three to four seconds.
3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Start Time: Comply with NFPA 110, Type 10, system requirements.

7. Excitation System: Performance shall be unaffected by voltage distortion caused by non-linear load.

F. Seismic Performance: Engine-generator set housing, engine-generator set, batteries, battery racks, silencers, and sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst case normal levels.

3. Component Importance Factor: 1.5.

2.3 ENGINE

A. Rated Engine Speed: 1800 rpm.

B. Alternator: Engine mounted belt drive 28v and 55 amp.

C. Lube Oil System: Forced-feed lubrication system with piston cooling, Lube oil circulating pump with safety valve, Lube oil filter, Lube oil heat exchanger, Filler neck, Dip stick and Closed crankcase breather system.

D. Combustion Air System: Exhaust turbo chargers, Intercooler integrated in radiator, Set of dry type air filters with contamination indicator and Air intake pipe work.

E. Cooling System: Coolant circulation pump, Engine mounted fan drive and Pusher fan.

F. Governor: Electronic Control through ECU, with speed sensing.

G. Coolant Jacket Heater: An electric water heater with integral thermostatic control. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

1. Cooling system: Closed loop, liquid cooled, with radiator factory mounted on engine-generator set mounting frame and integral engine-driven coolant pump.

2. Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

3. Size of radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent of load condition.

4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber.

a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.

b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

H. Muffler/Silencer: The silencer shall be critical grade.

1. An Exhaust silencer shall be furnished of industrial standard construction, all welded, for stationary engine application. Long radius, low restriction fittings

will be used throughout, and pipe size will be sufficiently large to handle the engine exhaust flow at full load without causing back pressure in excess of that allowed by the engine manufacturer.

I. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. Starting System: 12 or 24 volt electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.

2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.

3. Cranking Cycle: As required by NFPA 110 for system level specified.

4. Battery: Lead-acid with capacity within ambient temperature range specified to provide cranking cycle at least three times without recharging.

5. Battery Cable: Sized as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.

6. Battery Compartment: Plastic battery box which includes cover. Include accessories required to support and fasten batteries in place.

7. Battery Charger: 12 or 24VDC, current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

a. Operation: Minimum equalizing-charging rate of 10 amps shall be initiated automatically after battery has lost charge until and adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

b. Automatic Temperature Compensation: Must be equipped with temperature compensation to assure correct charging in all conditions.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 5 percent.

d. Ammeter and Voltmeter: Digital display shall indicate charging rates.

e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of AC input or DC output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

f. Enclosure and Mounting: NEMA-1.

2.4 DIESEL FUEL-OIL SYSTEM

A. Fuel System: Common rail fuel injection with low and high pressure fuel pumps, electronically controlled injection, main filter and pre-filter.

B. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

C. Lift Pump: Provides adequate pressure to main fuel pump mounted in engine.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief Bypass Valve: Automatically regulates pressure in fuel line and return excess fuel to source.

F. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.

2. Capacity: Fuel for 72 hours continuous operation at 100 percent rated power output.

3. Vandal-resistant fill cap.

4. Containment Provisions: Provide double-wall tank. Comply with UL142.

5. Leak detection in interstitial space.

2.5 CONTROLS AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, the generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Provide a minimum run time control set per NFPA 110. Override shall be provided only by a remote emergency stop switch.

C. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel rigidly mounted to the generator set. Panel shall be powered from the engine-generator set battery.

D. Digital Generator Controller

1. Generator Mounted Control Panel: Provide a generator mounted control panel.

2. Communications: USB and internal industrial grade Modem with dial out and dial in capability, SAE J1939 engine ECU capability and separate RS485 for providing communications to a remote display panel for NFPA 110 indication.

3. Generator Control Panel Protection Features: KWH/KVARH meter, Engine (Over speed, Battery Over/Under Voltage, Auxiliary Excitation and Speed/Frequency Mismatch), Generator (Over/Under Voltage, Over/Under Frequency, Unbalanced Voltage, Dead Bus Detection, Overload, Reverse/Reduced Power, Definite Over Current and Time Over Current, Inverse Time Over Current, Measured Ground Fault, Phase Rotation)

4. Environmental:

a. Temperature: Operating: -40 to 158°F, Storage: -40 to 185°F

b. Humidity: IEC 68-2-38

c. Salt Fog: ASTM B 17-73, IEC 68-2-11 (tested while operational)

d. Ingress Protection: IEC IP54 for front panel

e. Shock: 15 G in 3 perpendicular planes

f. Vibration:

1) 5 to 29 to 5 Hz: 1.5 G peak for 5 min.

2) 29 to 52 to 29 Hz: 0.036" DECS-A for 2.5 min.

3) 52 to 500 to 52 Hz: 5 G peak for 7.5 min.

5. Engine Control:

a. Cranking Control: Cycle or Continuous (Quantity and Duration Fully Programmable)

b. Engine Cool down

c. Successful Start Counter: Counts and records successful engine starts

d. Timers including, but not limited to:

1) Engine Cool down Timer

2) Engine Maintenance Timer

3) Pre-Alarm Time Delays for Weak/Low Battery Voltage

4) Alarm Time Delay for Over speed

5) Alarm Time Delay for Sender Failure.

6) Arming Time Delays after Crank Disconnect:

a) Low Oil Pressure

b) High Coolant Temperature

E. Indicating Devices: As required by NFPA 110 for Level 1 system including the following:

1. AC voltmeter.

2. AC ammeter.

3. AC frequency meter

4. EPS supplying load indicator

5. Ammeter and voltmeter phase-selector switches.

6. DC voltmeter (alternating battery charging).

7. Engine coolant temperature gage.

8. Engine lubricating oil pressure gage.

9. Running zone meter.

F. Protective Devices and Controls in Local Control Panel: Shutdown devices and common visual alarm indication as required by NFPA 110 for level 1 system, including the following:

1. Overcrank shutdown device
2. Overspeed shutdown devices
3. Coolant high temperature shutdown device
4. Low oil pressure shutdown device
5. Coolant low level shutdown device
6. Overcrank alarm
7. Overspeed alarm
8. Coolant high temperature alarm
9. Coolant low temperature alarm
10. Coolant low level alarm
11. Low oil pressure alarm
12. Lamp test
13. Contacts for local and remote common alarm
14. Main fuel tank low level alarm.
15. Shutdown engine when fuel level is below 10%
16. Run-off-auto switch
17. Control switch not in automatic position alarm
18. Low cranking voltage alarm
19. Battery charger malfunction alarm
20. Battery low voltage alarm
21. Battery high voltage alarm
22. Generator overcurrent protective device not closed alarm

G. 4-Relay: The 4-relay board includes (4) 10 amp form C relays customizable for user defined functionality requirements. Standard outputs as follows:

1. Engine Run
2. Engine Fail
3. Minor Alarm
4. Spare

H. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

I. Remote Alarm Annunciator: Designed for compliance with NFPA 110. LEDs labeled with proper alarm conditions identify each alarm as well as an audible signal for each alarm condition. Silencing switch in face of panel silences signal without altering visual

indication. Connect so that after an alarm is silenced, cleaning of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface or flush-mounting type as indicated on the drawings to suit mounting conditions indicated.

1. LED indications are provided for the following:
   a. Low Coolant Level
   b. High Engine Temperature
   c. Low Oil Pressure
   d. Overcrank
   e. Overspeed
   f. Emergency Stop Activated
   g. Coolant low-temperature alarm
   h. Low fuel tank alarm
   i. Low cranking voltage alarm
   j. Contacts for local and remote alarm
   k. High engine temperature pre-alarm
   l. Low Coolant Temperature
   m. Battery Overvoltage
   n. Battery low voltage
   o. Battery charger Failure
   p. Run-off-auto switch
   q. Display Panel On
   r. EPS Supplying Load
   s. Control switch not in automatic position alarm

J. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button to be protected from accidental operation.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: LSI adjustable electronic-trip type; 80 percent rated; complying with NEMA AB 1 and UL 489.
   1. Tripping Characteristic: Designed specifically for generator protection.
   2. Trip Rating: Refer to the one-line diagram on the contract drawings.
   3. Mounting: On generator set in an enclosure.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effects on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to the engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Drip proof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Analog voltage controller regulates voltage on 50 or 60 hertz brushless generators. The controllers include frequency compensation, over-excitation shutdown, solid-state buildup circuitry, and EMI filtering. Adjustment potentiometers are located on the terminals and components side of the controller. If remote adjustment of the generator output is desired, the Voltage Adjust Rheostat jumper must be replaced with a user-supplied rheostat. A 1000 ohm, ½-watt rheostat will provide adequate voltage adjustment range for most applications.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description:

1. Construction: Weatherproof formed and/or welded steel.
2. Hinged doors for access with lockable latches.
3. Louvered and/or baffled air inlet. Grated air outlet.
4. Choice of standard colors. Custom colors available upon request.

2.9 VIBRATION ISOLATION DEVICES

A. Neoprene Pad

1. ¼ inch thick elastomeric pad in square shape to be placed under the base frame at each of the pre-drilled isolator mounting holes.

2. Helps to prevent sliding of the unit as well as reducing the transmission of sound and vibration into the floor.

2.10 AUTOMATIC TRANSFER SWITCH

A. General

1. The automatic transfer switch shall be furnished by the manufacturer of the engine-generator set so as to maintain system compatibility and local service responsibility for the complete emergency power system. It shall be listed by Underwriter's Laboratory, Standard 1008 with fuse or circuit breaker protection. Representative production samples of the transfer switch supplied shall have demonstrated through tests the ability to withstand at least 10,000 mechanical operation cycles. One operation cycle is the electrically operated transfer from normal to emergency and back to normal. Wiring must comply with NEC table 312.6. The manufacturer shall furnish schematic and wiring diagrams for the particular automatic transfer switch and a typical wiring diagram for the entire system.

2. ASCO and Russelectric switches are acceptable equivalent manufacturers in addition to the manufacturers listed in this specification under section 2.1, A.

B. Ratings & performance

1. The automatic transfer switch shall be a 4 pole design. Refer to the drawings for voltage, ampacity and withstand ratings. The switch shall be rated for continuous operation in ambient temperatures of -20 degrees Fahrenheit (-30 degrees Celsius) to +140 degrees Fahrenheit (+60 degrees Celsius). The transfer switch supplied shall have a minimum withstand and closing rating when fuse protected of 200,000 amperes. Where the line side overcurrent protection is provided by circuit breakers, the short circuit withstand and closing ratings shall be minimum 22,000 amperes RMS or as indicated on the Drawings. These RMS symmetrical fault current ratings shall be the rating listed in the UL listing or component recognition procedures for the transfer switch. All withstand tests shall be performed with the overcurrent protective devices located external to the transfer switch.

C. Construction

1. The transfer switch shall be double throw construction, positively electrically and mechanically interlocked to prevent simultaneous closing and mechanically held in both normal and emergency positions. Independent break before make action shall be used to positively prevent dangerous source to source connections. When switching the neutral, this action prevents the objectionable ground currents and nuisance ground fault tripping that can result from overlapping designs. The transfer switch shall be approved for manual operation. The electrical operating means shall be by electric solenoid. Every portion of the contactor is to be positively mechanically connected. No clutch or friction drive mechanism is allowed, and parts are to be kept to a minimum. This transfer switch shall not contain integral overcurrent devices in the main power circuit, including molded case circuit breakers or fuses.

2. The transfer switch electrical actuator shall have an independent disconnect means to disable the electrical operation during manual switching. Maximum electrical transfer time in either direction shall be 160 milliseconds, exclusive of

time delays. Main switch contacts shall be high pressure silver alloy with arc chutes to resist burning and pitting for long life operation.

D. Controls

1. All control equipment shall be mounted on the inside of the cabinet door in a metal lockable enclosure with transparent safety shield to protect all solid state circuit boards. This will allow for ease of service access when main cabinet lockable door is open, but to prevent access by unauthorized personnel. Control boards shall have installed cover plates to avoid shock hazard while making control adjustments. The solid state voltage sensors and time delay modules shall be plug-in circuit boards with silver or gold contacts for ease of service.

2. A solid state undervoltage sensor shall monitor all phases of the normal source and provide adjustable ranges for field adjustments for specific application needs. Pick-up and drop-out settings shall be adjustable from a minimum of 70% to a maximum of 95% of nominal voltage. A utility sensing interface shall be used, stepping down system voltage to 24VAC, helping to protect the printed circuit board from voltage spikes and increasing personnel safety when troubleshooting.

3. Signal the engine-generator set to start in the event of a power interruption. A set of contacts shall close to start the engine and open for engine shutdown. A solid state time delay start, adjustable, .1 to 10 seconds, shall delay this signal to avoid nuisance start-ups on momentary voltage dips or power outages.

4. Transfer the load to the engine-generator set after it reached proper voltage, adjustable from 70-90% of system voltage, and frequency, adjustable from 80-90% of system frequency. A solid state time delay, adjustable from 5 seconds to 3 minutes, shall delay this transfer to allow the engine-generator to warm-up before application of load. There shall be a switch to bypass this warm-up timer when immediate transfer is required.

5. Retransfer the load to the line after normal power restoration. A return to utility timer, adjustable from 1-30 minutes, shall delay this transfer to avoid short term normal power restoration.

6. The operating power for transfer and retransfer shall be obtained from the source to which the load is being transferred. Controls shall provide an automatic retransfer of the load from emergency to normal if the emergency source fails with the normal source available.

7. Signal the engine-generator to stop after the load retransfers to normal. A solid state engine cooldown timer, adjustable from 1-30 minutes, shall permit the engine to run unloaded to cooldown before shutdown. Should the utility power fail during this time, the switch will immediately transfer back to the generator.

8. Provide an engine minimum run timer, adjustable from 5-30 minutes, to ensure an adequate engine run period.

9. The transfer switch shall have a time delay neutral feature to provide a time delay, adjustable from .1-10 seconds, during the transfer in either direction, during which time the load is isolated from both power sources. This allows residual voltage components of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. A switch will be provided to bypass all transition features when immediate transfer is required.

10. The transfer switch shall have an inphase monitor which allows the switch to transfer between live sources if their voltage waveforms become synchronous within 20 electrical degrees within 10 seconds of transfer initiation signal. A switch must be provided to bypass this feature if not required.

11. If the inphase monitor will not allow such a transfer, the control must default to time delay neutral operation. Switches with inphase monitors which do not default to time delay neutral operation are not acceptable.

12. Front mounted controls shall include a selector switch to provide for a NORMAL TEST mode with full use of time delays, FAST TEST mode which bypasses all time delays to allow for testing the entire system in less than one minute, or AUTOMATIC mode to set the system for normal operation.

13. Provide bright lamps to indicate the transfer switch position in either UTILITY (white) or EMERGENCY (red). A third lamp is needed to indicate STANDBY OPERATING (amber). These lights must be energized from utility or the engine-generator set.

14. Provide manual operating handle to allow for manual transfer. This handle must be mounted inside the lockable enclosure so accessible only by authorized personnel.

15. Provide a maintenance disconnect switch to prevent load transfer and automatic engine start while performing maintenance. This switch will also be used for manual transfer switch operation.

16. Provide LED status lights to give a visual readout of the operating sequence. This shall include utility on, engine warm-up, standby ready, transfer to standby, inphase monitor, time delay neutral, return to utility, engine cooldown and engine minimum run. A "signal before transfer" lamp shall be supplied to operate from optional circuitry.

E. ENCLOSURE

1. The transfer switch mechanism and controls are to be mounted in a NEMA 1 enclosure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator set performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install generator on concrete pad. Construct concrete pad in accordance with the manufacturer's recommendations.

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

E. Contractor shall install the complete electrical generating system including all fuel connections in accordance with the manufacturer's recommendations. Connect all piping to generator that is required for the system to operate. Install according to the manufacturer's instructions.

3.3 CONNECTIONS

A. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

B. Connect fuel piping to engines with a gate valve and union and flexible connector.

C. Ground equipment according to the manufacturer's instructions and the NEC.

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

3.4 IDENTIFICATION

A. Label all piping associated with the generator with painted stencil or adhesive wrap.

3.5 FACTORY TESTING

A. Before shipment of the equipment, the engine-generator set shall be tested under rated load for performance and proper functioning of control and interfacing circuits. Tests shall include:

1. Verifying all safety shutdowns are functioning properly.
2. Verify single step load pick-up per NFPA 110.
3. Verify transient and voltage dip responses and steady state voltage and speed (frequency) checks.
4. Before shipment of the transfer switch shall be tested under operating conditions for performance and proper functioning of control and interfacing circuits. Tests shall include:
5. Verify all timing sequences operate properly and are set to factory settings.
6. Verify the transfer mechanism operates properly.
7. Verify all manual operations and indicators are functioning properly.

3.6 STARTUP AND CHECKOUT

A. The supplier of the electric generating plant and associated items covered herein shall provide factory trained technicians to checkout the completed installation and to perform an initial startup inspection to include:

1. Ensuring the engine starts (both hot and cold) within the specified time.
2. Verification of engine parameters within specification.
3. Verify no load frequency and voltage, adjusting if required.
4. Test all automatic shutdowns of the engine-generator.

5. Perform a load test of the electric plant, ensuring full load frequency and voltage are within specification by using building load.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Document training attendees and video record training. Provide owner with a copy of the training video.

END OF SECTION 263213

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

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 lightning protection system for ordinary structures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFPA 780 for bonding of metal bodies.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lightning protection cabling attachments to roofing systems and accessories.
2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For lightning protection system to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."

b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

B. Completion Certificate:

1. UL Master Label Certificate.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: UL-listed installer, category OWAY or LPI Master Installer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.

B. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I buildings.

C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.2 Manufacturers

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

a. East Coast Lightning Equipment Inc.

b. ERICO International Corporation.

c. Harger.

d. Heary Bros. Lightning Protection Co. Inc.

e. Independent Protection Co.

f. Thompson Lightning Protection, Inc.

2.3 MATERIALS

A. All components shall be copper or aluminum as described below and of size, weight and construction to suit the application where used in accordance with the requirements of the appropriate structure class, applicable code requirements and manufacturer's recommendations. For structures where Class II equipment is required, Class 1 equipment may be used on portions of the roof area not exceeding 75' above grade.

B. No combination of materials shall be used that form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, conductors with protective coatings or oversize conductors shall be used. Where a mechanical hazard is involved, the conductor size shall be increased to compensate for the hazard or the conductors shall be protected by covering them with molding or tubing made of wood or nonmagnetic material. When metallic conduit or tubing is used, the conductor shall be electrically connected at the upper and lower ends.

C. Air Terminals:

1. Copper or Aluminum unless otherwise indicated.
2. 1/2-inch diameter by 12 inches long.
3. Pointed tip.
4. Integral base support.

D. Class 1 Main Conductors:

1. Stranded Copper: 57,400 circular mils in diameter.
2. Aluminum: 98,600 circular mils in diameter.

E. Secondary Conductors:

1. Stranded Copper: 26,240 circular mils in diameter.
2. Aluminum: 41,400 circular mils in diameter.

F. Ground Rods:

1. Material: Copper-clad steel.
2. Diameter: 5/8 inch.
3. Rods shall be not less than 120 inches long.

G. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A.

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed installations in UL 96A.

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: bolted connectors.

C. 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.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.

B. Prepare test and inspection reports and certificates.

END OF SECTION 264113

SECTION 265100 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Refer to the General Requirements Specifications, Section 260500.

B. Section Includes:

1. Interior and exterior lighting fixtures, lamps, ballasts, LED drivers.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.
5. Poles and accessories.

C. Refer to the light fixture schedule on the contract drawings for specific light fixture requirements and acceptable manufacturers.

D. Basis of Design light fixtures are described and listed on the fixture schedule with corresponding catalog numbers. Equivalent manufacturers listed in the schedule without corresponding catalog numbers are responsible for meeting the quality standards and photometric distribution set by the specified product.

1. Identification of the basis of design light fixtures by means of manufacturers' names and catalog numbers is to establish basic features, quality and performance standards, and it is not intended to limit competition. Any substitutions must meet or exceed these standards.

E. Substitutions and/or requests to have a manufacturer added as an acceptable equivalent manufacturer shall be made no later than 14 days prior to the bid date.

F. Those proposing substitutions shall submit the following to the engineer:

1. Cutsheets for each fixture. Cutsheets shall include at a minimum a picture and description of fixture construction, lamp type, efficiency and any accessories.
2. The engineer may require lighting calculations for specific areas to ensure the substitute fixtures will provide adequate lighting levels.

1.2 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting fixture, including housing, ballast LED array, electronic drivers and integral controls.

H. Pole: Luminaire support structure.

1.3 SUBMITTALS

A. 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 and poles including dimensions, materials and finishes.

2. Emergency lighting units including battery and charger.

3. LED drivers.

4. Life (L7O for LED), output (lumens, CCT, and CRI), and energy-efficiency data.

5. For lamp types other than integrated LED's, provide cutsheets for each lamp to be installed.

6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

7. Details of attaching luminaires and accessories.

8. Anchor bolts for poles.

9. Manufactured pole foundations.

10. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

B. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp, ballast and driver types used on the Project; use ANSI and manufacturers' codes.

2. Provide a list of all special warranties, per fixture type, that are longer than the standard one-year warranty.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLES

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lb, distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lb/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.

D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1. Basic wind speed for calculating wind load for poles 50 feet high or less is 100 mph.

a. Wind Importance Factor: 1.0.

b. Minimum Design Life: 25 years.

c. Velocity Conversion Factors: 1.0.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below ground line.

D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.6 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: The manufacturer agrees to replace or repair components that fail in material or workmanship within the specified period.

1. Warranty Period for Emergency Lighting Unit Batteries: Three years from the date of Substantial Completion.

2. Warranty Period for Emergency Self-Powered Exit Sign Batteries: Three years from the date of Substantial Completion.

3. The electrical contractor shall be responsible for replacing or repairing all components that fail within one year of the date of Substantial Completion.

4. Warranties that extend beyond one year after Substantial Completion shall apply to materials only. Labor is excluded after the first year.

B. Special warranty for LED luminaries and devices: The manufacturer agrees to repair or replace the driver and all components of the luminaire that fail in materials or workmanship or have a loss in performance within the specified warranty period listed below:

1. Warranty Period: Five (5) years from the date of substantial completion.

2. The electrical contractor shall be responsible for repairing or replacing all components that fail within one year of the date of substantial completion.

3. Warranties that extend beyond one year from the date of substantial completion shall apply to material only. Labor is excluded after the first year.

C. Special Warranty for Exterior Lighting: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.

3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

5. The Electrical Contractor shall be responsible for repairing or replacing all components that fail within one year of the date of substantial completion.

6. Warranties that extend beyond one year from the date of substantial completion shall apply to material only. Labor is excluded after the first year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers for lamp and ballast combinations:

1. GE lamps – GE ballasts

2. Osram Sylvania lamps – Osram Sylvania ballasts

3. Philips lamps – Advance ballasts

4. Philips or Osram Sylvania lamps – Lutron ballasts

2.2 GENERAL REQUIREMENTS FOR WARRANTIES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. LED Fixtures: Comply with UL 8750.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Plastic parts and acrylic lighting diffusers shall be 100 percent virgin acrylic plastic. Have a high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation. UV stabilized.

G. Integrated LED Luminaire Factory Applied Labels:

1. Each luminaire shall have the manufacturer's name, trademark, model number, serial number, date of manufacture and lot number as identification, permanently marked inside each unit and outside each packaging box.

2. The rated voltage, rated power in watts and volt-amperes shall be permanently marked inside each unit.

H. Exterior luminaires shall be U. L. listed and labeled for installation in wet locations. Interior luminaires located in wet environments shall be U. L. listed and labeled for installation in wet locations.

I. Luminaire efficiency ratings (LER) shall be tested according to NEMA standards for the type of fixture specified.

J. Luminaire Finish: manufacturer's standard or custom paint , as indicted in the Light Fixture Schedule, applied to factory-assembled and tested luminaires before shipping. Match finish for pole and support materials. Colors to be selected by Architect during shop drawing review.

K. LED Luminaire General Requirements

1. Each luminaire shall be tested to operate at an average ambient operating temperature of 25°C. Fixtures located in certain operating environments may require the ability to operate in higher or lower ambient temperature environment and still maintain their longevity, CCT and lumen output.

2. Each luminaire shall meet all parameters of this specification throughout the minimum operational life of 50,000 hours when operated at the average operating temperature.

3. The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation.

4. Polymeric materials (if used) of enclosures containing either the power supply or electronic components of the luminaire shall be made of UL94VO flame retardant materials. Luminaire lenses are excluded from this requirement.

5. The assembly and manufacturing process for the Solid State Lighting luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.

6. LED's shall be manufactured by a manufacturer who has produced commercial LEDs for a minimum of five (5) years.

7. Lumen Output – minimum initial delivered lumen output of the luminaire shall be the lumens exiting the luminaire in the 0-360 degree zone - as measured by IESNA Standard LM-79-08 in an accredited lab. Exact tested lumen output shall be clearly noted on the shop drawings.

8. Lumen output shall not decrease by more than 20% over the minimum operational life of 50,000 hours at the rated ambient operating temperature.

9. Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.

10. LED Boards shall be suitable for field maintenance and have plug-in connectors. LED boards shall be upgradable.

11. Light Color/Quality-

a. Correlated Color temperature (CCT), as indicated in the light fixture schedule, shall be correlated to chromaticity as defined by the absolute (X,Y) coordinates on the 2-D CIE chromaticity chart.

b. Color shift over 6,000 hours shall be <0.007 change in u' v' as demonstrated in IES LM80 report.

c. The color rendition index (CRI) shall be 80 or greater.

d. LED boards to be tested for color consistency and shall be within a space of 2.5 MacAdam ellipses on the CIE chromaticity chart.

12. Thermal Management

a. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.

b. The LED manufacturer's maximum junction temperature for the expected life shall not be exceeded at the average operating ambient.

c. The LED manufacturer's maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient.

d. The Driver manufacturer's maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.

2.3 INTEGRAL EMERGENCY POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast/driver. Comply with UL 924.

1. Emergency Connection: Operate fixtures continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

3. Battery: Sealed, maintenance-free, nickel-cadmium type.

4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

5. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

a. Battery: Sealed, maintenance-free, nickel-cadmium type.

b. Charger: Fully automatic, solid-state type with sealed transfer relay.

c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.5 LED POWER SUPPLIES AND DRIVERS

A. Driver shall meet or exceed the criteria herein:

a. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.

b. Driver should be UL Recognized under the component program and shall be modular for simple field replacement.

c. Electrical characteristics: 120 – 277 volt, UL Listed, CSA Certified, Sound Rated A+. Driver shall be > 80% efficient at full load across all input voltages. Input wires shall be 18AWG solid copper minimum.

d. Dimming: Driver shall be suitable for full-range dimming. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100 percent to 0.1 percent of rated lumen output with a smooth shut off function.

e. Dimming shall be controlled by a 0-10V signal, "DMX", forward phase or electronic low voltage as indicated in the fixture schedule and/or drawings.

f. Driver shall include ability to provide no light output when the control signal drops below 0.5 V, and shall consume 0.5 watts or less in this standby.

g. Driver shall be capable of configuring a linear or logarithmic dimming curve.

h. Drivers shall track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range regardless of the controller type.

i. Flicker: Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have:

1) Less than 1 percent flicker index at frequencies below 120 Hz.

2) Less than 12 percent flicker index at 120 Hz, and shall not increase at greater than 0.1 percent per Hz to a maximum of 80 percent flicker index at 800Hz.

j. Driver disconnect shall be provided.

k. The surge protection which resides within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C64.41 2002 for Location Category A, where failure does not mean a momentary loss of light during the transient event.

B. Electrical Requirements

1. Operation Voltage - The luminaire shall operate from at 60 HZ ±3 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage of plus or minus 10% shall have no visible effect on the luminous output.

2. Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

3. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage and meet ANSI C82.11 maximum allowable THD requirements.

4. In Rush Current: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps 2 – seconds.

5. RF Interference: The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions.

6. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:

7. Adjustment of forward LED voltage, supporting 3V through 60V.

8. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA

9. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.

10. Electrical connections between normal power and driver must be modular utilizing a snap fit connector. All electrical components must be easily accessible after installation and be replaceable without removing the fixture from the ceiling.

11. All electrical components shall be RoHS compliant.

2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.

2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Refer to the pole base details(s) on the Contract Drawings.

2.7 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: As indicted in the fixture schedule.

2. Mounting Provisions: Butt flange for bolted mounting on foundation.

B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.

2. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

2.8 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.

1. Shape: As indicated on the Contract Drawings.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Finish: Same as luminaire.

2.9 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the manufacturer's installation recommendations and guidelines.

B. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.

2. Install lamps in each luminaire.

C. Temporary Lighting: If it is necessary, and approved by the Engineer, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

D. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

E. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.

1. Install ceiling support system rods or wires for each fixture. Locate not more than 6 inches from all lighting fixture corners. Rods or wires shall be of the same gauge and style as other ceiling system support wires.

2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

4. Install at least two independent support rods or wires from the structure to tabs at diagonal corners of each lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

F. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.

2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet .

3. Trees: Outside of drip line.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth.

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.

2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

3.6 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Inspect each installed fixture for damage. Replace damaged fixtures and components.

C. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

D. Verify luminaires are operating seemlessly with the lighting controls.

END OF SECTION 265100

SECTION 271100 – COMMUNICATIONS EQUIPMENT ROOM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Telecommunications service entrance pathways.
5. Grounding.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Qualification Data: Provide copy of certifications for Installer and installation supervisor.

C. Seismic Qualification Certificates: For equipment frames from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff or certified by the material manufacturer to install their products.

1. Installation Supervision: Installation shall be under the direct supervision of certified installer, who shall be present at all times when Work of this Section is performed at Project site.

B. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

C. Grounding: Comply with ANSI-J-STD-607-A.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.5 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.

2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.

2. Straps and other devices. Cable straps shall be a reusable black Velcro cable wrap. No zip ties will be permitted.

3. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high and 2-1/2 inches deep.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment frames shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified

2.3 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, ¾ inches wide by 96 inches tall.

2.4 EQUIPMENT FRAMES

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

1. Panduit Corp.

2. Ortronics.

3. Hubbell Premise Wiring.

4. Middle Atlantic Products, Inc.
5. Chatsworth Products, Inc.
6. Great Lakes.

B. General Frame Requirements:

1. Distribution Frames: Freestanding, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310 standard, 19-inch panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. Floor-Mounted Racks: Modular-type, aluminum construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
2. Baked-polyester powder coat finish.
3. Racks shall be 84 inches tall.
4. Vertical grounding bus bar.
5. Power strip.
6. Equipment frame shall be seismic rated and secured to structure in accordance with manufacturer's requirements at top and bottom.

D. Wall Mounted Racks: Modular type, steel construction:

1. Two piece design.
2. 24.5 inches tall, 18 inches deep.
3. Side cutouts for easy cabling.
4. Provide one component shelf 14 inches deep and 3.5 inches tall.
5. Grounding bus bar.
6. Power strip.

E. Cable Management for Equipment Frames:

1. Plastic, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers on left and right side.
4. Provide horizontal crossover cable manager at the top of each patch panel or relay rack, with a minimum height of two rack units each.

2.5 POWER STRIPS

A. Manufacturer

1. Leviton
2. AMP Netconnect

B. Power Strips: Comply with UL 1363.

1. Rack mounted at bottom.
2. Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
3. LED indicator lights for power and protection status.
4. LED indicator lights for reverse polarity and open outlet ground.
5. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
6. Cord connected with 15-foot line cord and a NEMA L5-30 plug.
7. Rocker-type on-off switch, illuminated when in on position.
8. Peak Single-Impulse Surge Current Rating: 26kA per phase.
9. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.

2.6 GROUNDING

A. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide by 20 inches long with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

B. Rack mounted vertical grounding bus bar: Copper, sized for full height of rack, ¼ inch deep by 5/8 inch wide.

2.7 LABELING

A. 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.

B. Labels shall be self-laminating and machine generated.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Service entrance conduits shall extend no more than 6 inches above finished floor. Conduits shall be sealed.

3.2 COMMUNICATION EQUIPMENT ROOM CONSTRUCTION

A. Install telecommunications backboard on perimeter walls of each closet. Plywood sheets shall be installed vertically with the bottom installed at 12 inches above finished floor. Quantity of backboards shall be installed as required to cover all perimeter walls.

B. Install ladder runway around perimeter of room. Extend ladder runway from perimeter to above each rack or cabinet. Mount ladder runway above top of door frame. Coordinate exact height with conduit sleeves and other trades.

C. Install grounding bus bar in each closet.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 GROUNDING

A. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Install a No. 4 AWG telecommunications bonding backbone from each room's grounding bus bar to the electrical grounding system at the main service entrance.

B. Bond racks, cabinets and metal enclosures to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

C. Bond the shield of shielded cable to the rack mounted grounding bus bar. Use a No. 12 AWG conductor unless the manufacturer requires otherwise.

D. Bond patch panels to the rack mounted ground bus bar. Use a No. 12 AWG conductor unless the manufacturer requires otherwise.

E. Bond metallic conduits and conduit sleeves, entering and within the room, to the grounding bus bar. Install conductor not smaller than No. 6 AWG.

3.4 IDENTIFICATION

A. Label each rack with a unique identifier.

END OF SECTION 271100

SECTION 271500 – COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cabling.
3. Cable connecting hardware, patch panels, and cross-connects.
4. Telecommunications outlet/connectors.
5. Cabling system identification products.
6. Cable management system.
7. Install 1 cat 6 cable to each CCTV camera indicated on drawings, terminate on dedicated patch panel in nearest MDF/IDF, coordinate requirements with Section 17700 Video Surveillance System.

B. Related Sections:

1. Division 17 Section "Communications Equipment Room Fittings" for voice and data distribution room equipment.

C. Warranty:

1. Provide a 20 year end to end connectivity system performance warranty by system manufacturer. All materials provided shall comply with the manufacturer's warranty requirements. Installers shall be trained and certified by the manufacturer. Provide all documentation, testing and warranty registration in accordance with manufacturer's warranty requirements.

1.2 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. Bridged taps and splices shall not be installed in the horizontal cabling. Horizontal cabling shall be continuous.

B. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.

1.3 SUBMITTALS

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

1. UTP cabling.
2. Telecommunications outlets.
3. Patch panels.
4. Patch cords.

B. Qualification Data: provide copy of certifications for installer and installation supervisor.

C. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff or certified by the material manufacturer to install their products.

1. Installation Supervision: Installation shall be under the direct supervision of certified installer, who shall be present at all times when Work of this Section is performed at Project site.

B. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-A.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Comply with NFPA 70 and UL 2043 for fire resistant and low smoke producing characteristics.

2. Straps and other devices. All cable straps shall be reusable black Velcro cable wraps. No zip ties will be permitted.

2.2 UTP CABLE

A. Basis-of-Design Product: Subject to compliance with requirements, provide Panduit products or approved equal:

B. Description: 100-ohm, 4-pair UTP, with a thermoplastic jacket. Color as selected by the owner/engineer during shop drawing reviews.

1. Comply with ICEA S-90-661 for mechanical properties.

2. Comply with TIA/EIA-568-B.1 for performance specifications.

3. Comply with TIA/EIA-568-B.2, Category 6.

4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

   a. Communications, General Purpose: Type CM or CMG.

   b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

   c. Communications, Riser Rated: Type CMR, complying with UL 1666.

2.3 UTP CABLE HARDWARE

A. Basis-of-Design Product: Subject to compliance with requirements, provide Panduit products or approved equal:

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

   1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular patch panels with molded rear snap-in faceplates to accept modular jacks. Provide with labels.

   1. Number of Ports: One for each four-pair cable, plus 25 percent spare spaces.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

2.4 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular.

B. Workstation Outlets: Four-port-connector modular assemblies mounted in single or multigang faceplate.

   1. Faceplate: Coordinate color and material type with Division 26 Section "Wiring Devices."

      a. Provide Decora style faceplates to cover Decora style inserts.

   2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

      a. Flush mounting jacks installed in Decora style inserts.

      b. Decora style inserts shall be thermoplastic.

   3. Label: Machine generated, self-laminating, adhesive label.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. All communications cabling shall be installed above grade, with the exception of where they are installed to floor boxes or island furnishings. Where cabling is installed below grade, the cable must be rated for wet location installation.

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

5. Cables may not be spliced. Secure and support cables at intervals not exceeding 5 feet and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.

8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

10. Service Loops: In the communications equipment room, install a 10-foot-long service loop. Install a one-foot long service loop at the workstation. This loop

shall be coiled and attached to the conduit stub-up or stub-out above ceiling. The coil shall be a minimum of 12 inches in diameter.

11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.

2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by J-hooks not more than 60 inches apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

6. Separation between Communications Cables and Light Fixtures: A minimum of 5 inches.

3.3 FIRESTOPPING

A. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.

1. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

2. Color Code:

a. Data – Blue Cable with Orange jacks
b. Voice – Gray Cable with Ivory jacks
c. Station Alert System – Green Cable
d. Lighting Controls – Yellow Cable

B. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation.

1. Example Label – 121-A-1-D1, D2
a. 121 – Room number
b. A – Distribution frame identifier. IDF-A. Where cable originates.
c. 1 – Patch panel identifier. Where cable originates.
d. D1, D2 – Data jacks 1 and 2 in this outlet and room.

C. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cable and Wire Identification:

1. Label each cable at each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated. Provide three labels at each end, spaced 12 inches apart. The first label shall be installed within four inches of the termination. Labels shall be visible from all sides of cable.

2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

   a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.

   b. Label each unit and field within distribution racks and frames.

3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Use flexible vinyl or polyester, self-laminating, adhesive labels that flex as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Perform Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.

2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.

3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. UTP Performance Tests:

   a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

      1) Wire map.

      2) Length (physical vs. electrical, and length requirements).

      3) Insertion loss.

      4) Near-end crosstalk (NEXT) loss.

5) Power sum near-end crosstalk (PSNEXT) loss.

6) Equal-level far-end crosstalk (ELFEXT).

7) Power sum equal-level far-end crosstalk (PSELFEXT).

8) Return loss.

9) Propagation delay.

10) Delay skew.

5. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

b. Data Tests: Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

END OF SECTION 275100

SECTION 275116 - PUBLIC ADDRESS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Power amplifiers.
2. Equipment rack.
3. Telephone paging adapters.
4. Tone generator.
5. Loudspeakers.
6. Battery backup power unit.
7. Conductors and cables.
8. Pathways.
9. Interface with Station Alerting System for selective paging.
10. Door entry intercom/call system with interface to Access Contol System and Door Hardware for remote door release.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Power, signal, and control wiring.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
3. Control panels.
4. Rack arrangements.
5. Calculations: For sizing backup battery.
6. Wiring Diagrams: For power, signal, and control wiring.
    a. Identify terminals to facilitate installation, operation, and maintenance.
    b. Single-line diagram showing interconnection of components.
    c. Cabling diagram showing cable routing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For public address systems to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017700 "Closeout Procedures" and Section 017823 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

b. Operating instructions laminated and mounted adjacent to operating console location.

c. Training plan.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Personnel certified by NICET as Audio Systems Level II Technician.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain public address system from single source from single manufacturer.

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. Comply with NFPA 70.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions:

1. Selectively connect any zone to any available signal channel.

2. Selectively control sound from all inputs. Coordinate input impedance and line levels with input source characteristics.

3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.

4. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.

5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.

6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of nonuniform coverage of amplified sound.

7. Interface with Station Alerting System via dry contact closure provided from Station Alert System for selective paging zone activation by Alerting System. Station Alert System shall have priority over any other input signals.

2.3 SYSTEM DESCRIPTION

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with EIA/ECA-310-E.

D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

2.4 PREAMPLIFIERS

A. Preamplifier: Integral to power amplifier.

B. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.

C. Total Harmonic Distortion: Less than 1 percent.

D. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.

E. Input Jacks: Minimum of three. One matched for low-impedance microphone; one USB port; and the other matchable to DVD or CD player, or radio tuner signals without external adapters.

F. Minimum Noise Level: Minus 55 dB below rated output.

G. Controls: On-off, input levels, and master gain.

2.5 POWER AMPLIFIERS

A. Multi-Channel Digital Power Amplifier

B. Mounting: Rack.

C. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus a 25 percent allowance for future stations.

D. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.

E. Minimum Signal-to-Noise Ratio: 80 dB, at rated output.

F. Frequency Response: Within plus or minus 3 dB from 20 to 12,000 Hz.

G. Output Regulation: Less than 2 dB from full to no load.

H. Controls: On-off, input levels, and low-cut filter.

I. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

2.6 EQUIPMENT RACK

A. Wall mount Rack: 19 inches standard, complying with EIA/ECA-310-E.

B. Power-Supply Connections: Compatible plugs and receptacles.

C. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.

D. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with cartridge fuse protection for rack equipment power.

E. Service Light: At top rear of rack with an adjacent control switch.

F. Vertical Plug Strip: Grounded receptacles, 12 inches o.c.; the full height of rack for public address system equipment use only.

G. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.

H. Spare Capacity: 20 percent in rack for future equipment.

2.7 TELEPHONE PAGING ADAPTER

A. Adapters shall accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for preselected zones.

1. Minimum Frequency Response: Flat, 200 to 2500 Hz.

2. Impedance Matching: Adapter matches telephone line to public address equipment input.

2.8 TONE GENERATOR

A. Signals: Minimum of seven distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.

B. Pitch Control: Chimes and tone.

C. Volume Control: All outputs.

D. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.

2.9 LOUDSPEAKERS

A. Cone-Type Loudspeakers:

1. Minimum Axial Sensitivity: 91 dB at 1 m, with 1-W input.

2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.

3. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.

4. Rated Output Level: 10 W.

5. Minimum Dispersion Angle: 100 degrees.

6. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.

7. Surface-Mounted Units: Ceiling, wall, or pendant mounted, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch steel and whole assembly rust proofed and shop primed for field painting.

8. Flush-Ceiling-Mounted Units: In steel back boxes, acoustically dampened. Metal ceiling grille with white baked enamel.

B. Horn-Type Loudspeakers:

1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
2. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
3. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
4. Dispersion Angle: 130 by 110 degrees.
5. Mounting: Integral bracket.
6. Units in Damp, Wet, or Outdoor Locations: Listed and labeled for environment in which they are located.

2.10 OUTLETS

A. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.

1. Wattage Rating: 10 W unless otherwise indicated.
2. Attenuation per Step: 3 dB, with positive off position.
3. Insertion Loss: 0.4 dB maximum.
4. Attenuation Bypass Relay: SPDT. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.

2.11 BATTERY BACKUP POWER UNIT

A. Unit shall be rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.

B. Unit shall supply public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.

C. Battery shall be on float charge when not supplying system and able to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.

D. Unit shall automatically retransfer system to normal supply when normal power has been reestablished for three to five seconds continuously.

2.12 CONDUCTORS AND CABLES

A. Jacketed, twisted pair and twisted multipair, untinned solid copper.

1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
2. Plenum Cable: Listed and labeled for plenum installation.

2.13 PATHWAYS

A. Conduit and Boxes: Comply with Section 260533 "Raceways and Boxes". Flexible metal conduit shall not be used.

1. Outlet boxes shall be not less than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces where unenclosed wiring method may be used. Conceal pathway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements in Section 260533 "Raceways and Boxes" for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.

2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.

3. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.

3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate pathways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other communication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

C. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

D. Equipment Cabinets and Racks:

1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.

2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.

3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

E. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.

F. Wall-Mounted Outlets: Flush mounted.

G. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

H. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

I. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

J. Connect wiring according to Section 271500 "Communications Horizontal Cabling" and Section 280513 "Conductors and Cables for Electronic Safety and Security."

3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3.6 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. 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.

C. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.

2. After installing public address system and after electrical circuitry has been energized, test for compliance with requirements.

3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.

4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.

b. Repeat test for each separately controlled zone of loudspeakers.

c. Minimum acceptance ratio is 50 dB.

5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.

6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.

7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Section 270526 "Grounding and Bonding for Communications Systems."

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

E. Public address system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

1. Include a record of final speaker-line matching transformer-tap settings and signal ground-resistance measurement certified by Installer.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

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

3.8 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. 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 a minimum of two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address system and equipment. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 275116

SECTION 281300 - ACCESS CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Expansion of existing City network connected eMerge Access Control System which will operate across the LFUCG computer network.
2. Security access controllers connected to high-speed electronic-data transmission network.
3. System shall interface and be connected to door control hardware (electrified locks, magnetic locks, door monitor switches, gates, other monitoring contacts and control devices, etc.) as specified in other applicable divisions of this specification.
4. The work covered by this section of the Specifications includes the furnishing of all labor, equipment, materials, and performance of all operations associated with the installation of the security system as shown on the Drawings and as herein specified

1.3 QUALITY ASSURANCE

A. The manufacturer of the product specified in this section shall have a minimum of five (5) years of documented experience in the manufacture and design of access control and site management systems.

B. The supplier shall be a factory authorized vendor for the access control and site management system specified and a minimum of three (3) years of documented experience installing and servicing similar systems.

C. Installer Qualifications: An employer of workers trained and certified by manufacturer.

D. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

E. 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.

F. Comply with NFPA 70, "National Electrical Code."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Diagrams for cable management system.

2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.

3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:

   a. Workstation outlets, jacks, and jack assemblies.

   b. Patch cords.

   c. Patch panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide eMerge system products as manufactured by IEI and compatible with existing LFUCG system head end equipment.

2.2 DESCRIPTION

A. The Access Control System shall monitor and control facility access. System shall also support alarm monitoring, camera and video monitoring, communications loss monitoring, and temperature monitoring applications. The system shall also maintain a database of system activity, personnel access control information, and system user passwords and user role permissions. Virtual inputs such as video loss and building occupancy limits exceeded shall also be supported. The system shall be controlled from a web browser and require no software installation or client licenses. The system shall provide control and access to users on Local Area Networks (LAN), Wide Area Networks (WAN), wireless networks, and the Internet. The system shall provide email and/or text message alerts for all alarm conditions and threats.

B. The system shall be implemented through network appliance architecture with a three-tiered modular hardware hierarchy and embedded three-tier software architecture.

C. The system shall integrate, in a browser interface, access control, alarm monitoring, video monitoring, and temperature monitoring applications.

2.3 NETWORK EXPANSION NODE

A. Surge and tamper protection.

B. Expansion node(s) shall be an eMerge EXN series of type and quantity necessary to interface and connect doors indicated on Drawings.

C. The network device shall run on existing building TCP/IP networks and shall be configurable for access from separate subnets, through gateways and routers, and from the internet.

D. Expansion node The MicroNode shall shall utilize 12VDC power at 3 Amps or Power over Ethernet (PoE) at the 802.3AF standard.

2.4 CARD READERS, CREDENTIAL CARDS, AND KEYPADS

A. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.

B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

D. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

E. Touch-Plate and Proximity Readers:

1. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
2. Passive-detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
3. The card reader shall read proximity cards in a range from direct contact to at least 6 inches from the reader.

2.5 POWER SUPPLY

A. Fused power supply with battery backup. Altronix AL400ULM or equivalent multi-outuput access control power supply/charger; quantity as required

B. Provide power for all access control system equipment including power to electrified locks furnished with Door Hardware, coordinate requirement and connection with Door Hardware supplier.

2.6 CABLES

A. General Cable Requirements: Provide cable as recommended by system manufacturer for power, control and system integration requirements. Cable shall be plenum rated.

1. Proximity Card Reader: 3C/18AWG, stranded, shielded
2. Door Contact: 2C/22AWG, stranded, shielded
3. Electric Lock Power: 2C/18AWG, stranded, shielded
4. Request to Exit: 4C/22AWG, stranded, shielded

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

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

3.2 INSTALLATION

A. Provide all equipment, mounting brackets, wiring, conduit and outlet boxes required for the installation of a complete and operating system in accordance with applicable local, state and national codes, the manufacturer's recommendations, these plans and specifications. All circuits not in conduit must be wired with power limited or non-power limited cable as listed under NEC 725 Class II wiring. Color coded wires shall be used throughout. Wiring shall conform to the practices in the National Electrical Code.

B. Wiring Method: In raceway or cable tray except within cabinets and concealed in accessible ceiling spaces.

C. Comply with TIA 569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."

D. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft..
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

E. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft.

F. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

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. Test Procedure: TIA/EIA-568-B.1.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system."

END OF SECTION 281300

SECTION 283111 – DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Carbon monoxide detectors
5. Heat detectors.
6. Notification appliances.
7. Remote annunciator.
8. Addressable interface device.
9. Digital alarm communicator transmitter.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

1.5 SUBMITTALS

A. 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 III minimum.
   c. Licensed or certified by authorities having jurisdiction.

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

C. 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 floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. 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.

F. Qualification Data: For qualified Installer.

G. Field quality-control reports.

H. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," 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.

7. Copy of NFPA 25.

I. 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 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 II technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

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. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.

1.7 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. NOTIFIER; a Honeywell company.

2. Edwards/EST.

3. Siemens.
4. Silent Knight.
5. Fike

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Verified automatic alarm operation of smoke detectors.
6. Automatic sprinkler system water flow.
7. Fire-extinguishing system operation.
8. Fire standpipe system.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Activate emergency shutoffs for gas and fuel supplies.
9. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.

8. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

b. Include a real-time clock for time annotation of events on the event recorder and printer.

2. Addressable initiation devices that communicate device identity and status.

a. Smoke sensors shall additionally communicate sensitivity setting.

b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 80 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.

a. Initiating Device Circuits: Style D.

b. Notification Appliance Circuits: Style Z.

c. Signaling Line Circuits: Style 5.

d. Install no more than 50 addressable devices on each signaling line circuit.

2. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
   a. Initiating Device Circuits: Style B.
   b. Notification Appliance Circuits: Style X .
   c. Signaling Line Circuits: Style 3.
   d. Install no more than 50 addressable devices on each signaling line circuit.
3. Serial Interfaces: Two RS-232 ports for printers.

D. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

F. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

H. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals,supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
1. Batteries: Vented, wet-cell pocket, plate nickel cadmium.

J.Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall

be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key operated switch.

2.6 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
   c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.7 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.
   1. Mounting: Adapter plate for outlet box mounting.
   2. Testable by introducing test carbon monoxide into the sensing cell.
   3. Detector shall provide alarm contacts and trouble contacts.
   4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
   5. Comply with UL 2075.
   6. Locate, mount, and wire according to manufacturer's written instructions.
   7. Provide means for addressable connection to fire-alarm system.
   8. Test button simulates an alarm condition.

2.8 MULTICRITERIA DETECTORS

A. Mounting: Twist-lock base interchangeable with smoke-detector bases.

B. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.

D. Test button tests all sensors in the detector.

E. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   1. Primary status.
   2. Device type.

3. Present sensitivity selected.
4. Sensor range (normal, dirty, etc.).

F. Sensors: The detector shall be comprised of four sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor.

1. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
2. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
3. Each sensor shall be separately listed according to requirements for its detector type.

2.9 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.

1. Mounting: Adapter plate for outlet box mounting.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.10 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.

B. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

D. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch high letters on the lens.

1. Rated Light Output:
   a. 15/30/75/110 cd, selectable in the field.
2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.

2.11 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.12 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply or loss of power.
5. Low battery.
6. Abnormal test signal.
7. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.14 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of device.

2. Finish: Paint of color to match the protected device.

2.15 SURGE PROTECTION

A. Acceptable Manufacturers:

1. 120Volt/20 Amp – Ditek 120SR

2. Analog Dialer – Ditek 2MHTPWB

3. IP Dialer – Ditek MRJ45C5E

4. Exterior Fire Alarm Circuits – Ditek LVLP Series

5. The above list of equipment represents a minimum standard of quality. It is not intended to limit the acceptable manufacturers. Equivalent surge protection devices may be provided by other manufacturers.

B. Provide surge protection for the following:

1. 120 Volt AC circuits connected to the control panel, extender panels and any other fire alarm device requiring 120 Volt connections.

2. All exterior fire alarm circuits.

3. IP or analog automatic dialers. Provide protection on the telephone or data cables extending to/from the dialer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.

2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.

3. Smooth ceiling spacing shall not exceed 30 feet.

4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.

5. HVAC: Locate detectors not closer than 5 feet from air-supply diffuser or return-air opening.

6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a

lighting fixture.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Connect the integral relay to the associated HVAC equipment as required to shut down the fan(s). Coordinate all work with the Mechanical contractor.

D. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

E. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

F. Provide distinctive signal for carbon monoxide alarms in accordance with NFPA requirements.

G. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

H. Device Location-Indicating Lights: Locate in public space near the device they monitor.

I. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

J. Annunciator: Install with top of panel not more than 72 inches above the finished floor, recessed mounting.

3.2 PATHWAYS

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.

2. Provide recessed outlet box with conduit stub to accessible ceiling for wall mounted devices in finished spaces.

3.3 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.

2. Smoke dampers in air ducts of designated air-conditioning duct systems.

3. Supervisory connections at valve supervisory switches.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Basic Electrical Material and Methods."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.6 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. 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.

D. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of

added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

3.9 MONITORING

A. The contractor is responsible for providing a U.L. Listed fire alarm monitoring service for one year after substantial completion.

END OF SECTION 283111

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.2 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

D. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.

7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material from off-site sources.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
2. Use only hand methods for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 GEOTECHNICAL REPORT.

A. A geotechnical report, prepared by AMEC of Lexington, Kentucky can be found in Division 1 of this Project manual. The report is provided for informational purposes only to aid in the understanding of the subsurface site conditions and is not to be considered part of the contract documents for this project.

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for pavements, turf and grasses and plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete pavements.
5. Subbase course and base course for asphalt paving.
6. Excavating and backfilling for utility trenches.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil borrowed from on-site locations for use as fill or backfill. Source location is in the area of the future soccer complex. All excavation done in borrow areas must be performed in a manner that benefits future construction and development of those areas. Contractor to coordinate operations with Owners representative.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

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

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 2" in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. 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.

E. 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.

F. 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.

G. 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.

H. Drainage Course: Narrowly graded mixture of 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.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.

B. 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 to comply with local practice or requirements of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 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.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

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

1. Clearance: As indicated in drawings.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.6 SUBGRADE INSPECTION

A. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.7 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, pipe, or conduit as directed by Architect.

3.8 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.

3.9 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. Trenches under Footings: 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. Trenches under Roadways: 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 or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course.

E. Place and compact initial backfill free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

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

G. 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 grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

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 in 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 or ASTM D 1557:

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 100 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 98 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 90 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.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

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

3.14 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Shape subbase course and base course to required crown elevations and cross-slope grades.
2. Place subbase course and base course that exceeds 4 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 4 inches thick or less than 3 inches thick.
3. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D 698 or ASTM D 1557.

3.15 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

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

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.17 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.

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.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes construction dewatering.

1.2 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, discharge lines, piezometers, and flow-measuring devices; and means of discharge, control of sediment, and disposal of water.

B. Delegated-Design Submittal: For dewatering system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Preinstallation Conference: Conduct conference at Project site.

1.5 PROJECT CONDITIONS

A. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide temporary grading to facilitate dewatering and control of surface water.

B. Monitor dewatering systems continuously.

C. Protect and maintain temporary erosion and sedimentation controls, which are specified during dewatering operations.

D. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

E. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

F. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

G. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.

H. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

END OF SECTION 312319

SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil treatment with termiticide.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the EPA-Registered Label for termiticide products.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Soil Treatment Application Report: Include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

C. Warranties: Sample of special warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.

B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.6 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

1. Warranty Period: Five years from date of Substantial Completion.

1.7 MAINTENANCE SERVICE

A. Continuing Service: Beginning at Substantial Completion, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

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

a. BASF Corporation, Agricultural Products; Termidor.
b. Bayer Environmental Science; Premise 75.
c. FMC Corporation, Agricultural Products Group; Dragnet FT.
d. Syngenta; Prelude.

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 APPLICATION, GENERAL

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.2 APPLYING SOIL TREATMENT

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

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

C. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

D. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.

1. Slabs-on-Grade and Basement Slabs: Underground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
3. Crawlspaces: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
4. Masonry: Treat voids.
5. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

E. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

F. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

G. Post warning signs in areas of application.

H. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313116

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold milling of existing hot-mix asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt paving overlay.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
2. Job-Mix Designs: For each job mix proposed for the Work.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each paving material, from manufacturer.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Tack Coat: Minimum surface temperature of 60 deg F.
2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.

3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

B. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

C. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22.

B. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

2.4 MIXES

A. Surface Course Limit: Recycled content no more than **10** percent by weight.

B. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

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

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 2 inches.

3.3 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Spread mix at minimum temperature of 250 deg F.
2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes Concrete Paving
   1. Driveways.
   2. Roadways.
   3. Parking lots.
   4. Curbs and gutters.
   5. Walks.

1.2 ACTION SUBMITTALS

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

B. Samples: For each exposed product and for each color and texture specified.

C. Other Action Submittals:

   1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1.4 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. ACI Publications: Comply with ACI 301 unless otherwise indicated.

C. Sample Panels: Build sample panels to verify quality and craftsmanship to demonstrate aesthetic effects for acceptance by architect and owner. Comply with requirements in other sections for mockups.
   1. Build sample panels for each typical pour size and thickness on project.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

E. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

F. Deformed-Steel Wire: ASTM A 496/A 496M.

G. Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

H. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, white portland cement Type I.

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

B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

2.3 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.4 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

2.5 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:

1. Compressive Strength (28 Days): 4000 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
3. Slump Limit: 3 inches, plus or minus 1 inch.
4. Air Content: 5-1/2 percent plus or minus 1.5 percent.

B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

2.6 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

B. Remove loose material from compacted subbase surface immediately before placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness:

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Concrete placement for purposes of contractor use is not permitted unless contractor places for their use and removes and replaces at the end of project. Per owner request, concrete placement for parking or drive aisles is not to be installed until the end of project duration to protect from construction traffic and damage.

B. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

C. Comply with ACI 301 requirements for measuring, mixing, transporting, placing, and consolidating concrete.

D. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

E. Screed paving surface with a straightedge and strike off.

F. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

G. Concrete shall be placed in appropriate quantities per ACI 301 and ACI 117 but shall be capable of being worked and finished to the satisfaction of the owner and architect per the mock-ups approved.

3.6 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
   2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these.

3.8 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
4. Joint Spacing: 3 inches.
5. Contraction Joint Depth: Plus 1/4 inch, no minus.
6. Joint Width: Plus 1/8 inch, no minus.

3.9 PAVEMENT MARKING

A. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.10 WHEEL STOPS

A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.

B. Securely attach wheel stops to paving with not less than two galvanized-steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.

1.2 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, eight, Samples of materials that will contact or affect joint sealants. Use manufacturer's standard test method to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples: For each kind and color of joint sealant required.

C. Pavement-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

C. Preconstruction compatibility and adhesion test reports.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and

application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.

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

a. Crafco Inc., an ERGON company; RoadSaver Silicone SL.
b. Dow Corning Corporation; 890-SL.
c. Pecora Corporation; 300 SL.

2.3 JOINT-SEALANT BACKER MATERIALS

A. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

B. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Cleaning of Joints: Clean out joints immediately before installing joint sealants.

C. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

D. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place joint sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

G. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

H. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

END OF SECTION 321373

SECTION 321713 - PARKING BUMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes wheel stops.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 PARKING BUMPERS

A. Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete, 4000-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Mounting Hardware: Galvanized-steel **lag screw, shield, and washers; 1/2-inch diameter, 10-inch minimum length and hardware as standard with wheel-stop manufacturer.**

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install wheel stops according to manufacturer's written instructions unless otherwise indicated.

B. Install wheel stops in bed of adhesive before anchoring.

C. Securely anchor wheel stops to pavement with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer.

END OF SECTION 321713

SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes painted markings applied to asphalt pavement.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide one of the following:

1. Aexcel Inc.
2. Benjamin Moore & Co.
3. Color Wheel Paints & Coatings.
4. Columbia Paint & Coatings.
5. Conco Paints.
6. Coronado Paint; Division of INSL-X Products Corporation.
7. Diamond Vogel Paints.
8. Dunn-Edwards Corporation.
9. Ennis Traffic Safety Solutions, Inc.
10. Frazee Paint.
11. General Paint.
12. Kwal Paint.
13. M.A.B. Paints.
14. McCormick Paints.
15. Miller Paint.
16. Parker Paint Mfg. Co. Inc.
17. PPG Industries.
18. Pratt & Lambert.
19. Rodda Paint Co.
20. Rohm and Haas Company; a subsidiary of The Dow Chemical Company.
21. Scott Paint Company.
22. Sherwin-Williams Company (The).

2.2 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint: MPI #32, alkyd traffic-marking paint.

1. Color: White.

B. Pavement-Marking Paint: MPI #97, latex traffic-marking paint.

1. Color: White.

PART 3 - EXECUTION

3.1 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils. Apply paint so that it cannot run beneath the stencil.
2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal.

END OF SECTION 321723

SECTION 321726 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Detectable warning mats applied to existing concrete paving.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for each type of exposed finish requiring color selection.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for tactile warning surfaces.

   1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

2.2 DETECTABLE WARNING MATS

A. Surface-Applied Detectable Warning Mats: Accessible truncated-dome detectable warning resilient mats, UV resistant, manufactured for adhering to existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of mat, and beveled outside edges.

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

      a. AlertTile; a division of Cape Fear Systems, II, LLC.

   2. Material: Modified rubber compound, UV resistant.
   3. Color: Federal Yellow No. 33538.
   4. Shapes and Sizes:

      a. Rectangular panel, Provide maximum length of panel by 24" per site location.

5. Dome Spacing and Configuration: 1.67-inch spacing, in pattern.
6. Mounting: Adhered to pavement surface with adhesive and fastened with fasteners.

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish Type 304 stainless-steel fasteners for exterior use.
2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

C. Cast-in-Place Detectable Warning Tiles: Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. Set surface of tile flush with surrounding concrete and adjacent tiles. Remove concrete from tile surfaces and clean using methods recommended in writing by manufacturer.

D. Removable Cast-in-Place Detectable Warning Tiles: Set each detectable warning tile accurately and firmly in place with embedding anchors and fasteners attached, and firmly seat tile back in wet concrete by tamping or vibrating. Set surface of tile flush with surrounding concrete and adjacent tiles. Remove concrete from tile surfaces and clean tiles using methods recommended in writing by manufacturer.

E. Surface-Applied Detectable Warning Tiles: Prepare existing paving surface by grinding and cleaning as recommended by manufacturer. Apply adhesive to back of tiles in amounts and pattern recommended by manufacturer, and set tiles in place. Install anchor devices through face of tiles and into pavement using anchors located as recommended by manufacturer. Apply sealant in continuous bead around perimeter of installation.

F. Surface-Applied Detectable Warning Mats: Prepare existing paving surface by grinding and cleaning as recommended by manufacturer. Apply adhesive to back of mat and set mat in place.

Firmly seat mat in adhesive bed. Install anchor devices through face of mat and into pavement using anchors located as recommended by manufacturer. Set heads of anchors flush with mat surface. Apply sealant in continuous bead around perimeter of mat.

G. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

H. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 321726

SECTION 329200 - SOD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sodding.

1.2 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Whatever soil is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Certification of grass seed.

1. Certification of each seed mixture for turfgrass sod.

B. Product certificates.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1.6 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

1. Pesticide Applicator: State licensed, commercial.

B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.

1. The soil-testing laboratory shall oversee soil sampling.
2. Report suitability of tested soil for turf growth.

a. State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
b. Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

1.8 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Sodded Turf: 12 months from date of planting completion.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows:

1. Superior sod grown from certified, high quality seed of known origin or from plantings of certified grass or seedlings.

2. Sod Seed Mix:
   1) All disturbed areas shall be sodded with a predominately tall type Fescue mixture such as prescribed below:
      a) 40% Grande II Turf Type Tall Fescue
      b) 20% Falcon IV Turf Type Fescue
      c) 20% Cochise III Turf Type Tall Fescue
      d) 10% Award Kentucky Bluegrass
      e) 10% Pizzazz Perennial Ryegrass

3. Sow seed at the rate of 7 pounds per 1,000 square feet.

4. Contractor shall verify in written communication to the Owner the exact amount of seed sowed.

2.2 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 2 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.3 PLANTING SOILS

A. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 2 percent organic material content. Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process. Existing, in-place surface soil.. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

1. Ratio of Loose Compost to Topsoil by Volume: 1:4.
2. Weight of Lime per 1000 Sq. Ft. per soil analysis
3. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. per soil analysis.

2.4 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

C. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings.

2.5 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 TURF AREA PREPARATION

A. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Reduce elevation of planting soil to allow for soil thickness of sod.
2. Apply fertilizer directly to subgrade before loosening.

3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.

4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.3 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain height appropriate for species without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings.

C. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.4 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:
   1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

END OF SECTION 329200

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.

1.2 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

C. Finish Grade: Elevation of finished surface of planting soil.

D. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

F. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

G. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

H. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

I. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

J. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

K. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

B. Samples of hardwood bark mulch.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

1.5 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.

1. The soil-testing laboratory shall oversee soil sampling.
2. Report suitability of tested soil for plant growth.

    a. State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
    b. Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

C. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

D. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

B. Handle planting stock by root ball.

C. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

D. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.7 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
b. Structural failures including plantings falling or blowing over.

2. Warranty Periods from Date of Planting Completion:

a. Trees, Shrubs, Vines, and Ornamental Grasses: 24 months.
b. Ground Covers, Biennials, Perennials, and Other Plants: 24 months.
c. Annuals: 12 months.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period for Trees and Shrubs: 12 months from date of planting completion.
2. Maintenance Period for Ground Cover and Other Plants: 12 months from date of planting completion.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated

when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or granular texture, with a pH range of 3.4 to 4.8.

2.4 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

C. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 5-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.5 PLANTING SOILS

A. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 2 percent organic material content. Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process.. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
1. Ratio of Loose Sphagnum Peat to Topsoil by Volume: 1:4.

2.6 MULCHES

A. Organic Mulch: Shredded hardwood.

PART 3 - EXECUTION

3.1 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter.
2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.

B. Subsoil and topsoil removed from excavations may be used as planting soil.

3.2 TREE, SHRUB, AND VINE PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Set stock plumb and in center of planting pit or trench with root flare 1-2 inches above adjacent finish grades.

1. Use planting soil for backfill.
2. Balled and Burlapped: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Balled and Container-Grown: Carefully remove root ball from container without damaging root ball or plant.
4. Fabric Bag-Grown Stock: Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
5. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
6. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
7. Continue backfilling process. Water again after placing and tamping final layer of soil.
8. Retain first subparagraph below if planting soil type is not indicated on Drawings; revise if other types of backfill are required.
9. Use planting soil for backfill.
10. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots.
11. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside soil-covered roots about 1 inch from root tips; do not place tablets in bottom of the hole or touching the roots.
12. Continue backfilling process. Water again after placing and tamping final layer of soil.

3.3 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

3.4 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on the plant list.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.5 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

3.6 PLANT MAINTENANCE

A. Maintain plantings for specified times as stated in Section 1. This includes pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use practices to minimize the use of pesticides and reduce hazards.

D. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

E. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

END OF SECTION 329300

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Manholes.
3. Cleanouts.
4. Nonpressure transition couplings.
5. Catch basins.
6. Stormwater inlets.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins. Include plans, elevations, sections, details, frames, covers, and grates.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

C. Field quality-control reports.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1.5 PROJECT CONDITIONS

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

1. Notify Owner no fewer than two days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
2. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
2. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.2 CONCRETE PIPE AND FITTINGS

A. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14, Class 3, with tongue-and-groove ends and gasketed joints with ASTM C 443, rubber gaskets.

B. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.

1. Tongue-and-groove ends and gasketed joints with ASTM C 443, rubber gaskets

2.3 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Light Duty, Medium Duty, Heavy Duty, and Extra-Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.4 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.5 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

   a. Invert Slope: 2 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

   a. Slope: 8 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.6 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
8. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches.
9. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.7 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to utility standards.

B. Gutter Inlets: Made with horizontal gutter opening, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

D. Frames and Grates: Heavy duty, according to utility standards.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.

2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install piping with 36-inch minimum cover.
4. Install PE corrugated sewer piping according to ASTM D 2321.
5. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
6. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
2. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
3. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
4. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.9 CHANNEL DRAINAGE SYSTEM INSTALLATION

A. Install with top surfaces of components, except piping, flush with finished surface.

B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.

C. Embed channel sections and drainage specialties in 4-inch minimum concrete around bottom and sides.

D. Fasten grates to channel sections if indicated.

E. Assemble channel sections with flanged or interlocking joints.

F. Embed channel sections in 4-inch minimum concrete around bottom and sides.

3.10 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Connect to sediment interceptors specified in Section 221323 "Sanitary Waste Interceptors."

3.11 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.12 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.

d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
b. Option: Test plastic piping according to ASTM F 1417.
c. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 334100

SECTION 334600 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Perforated-wall pipe and fittings.
2. Geotextile filter fabrics.

1.2 ACTION SUBMITTALS

A. Product Data: For geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.

2.2 SOIL MATERIALS

A. Soil materials are specified in Section 312000 "Earth Moving."

2.3 WATERPROOFING FELTS

A. Material: Comply with ASTM D 226, Type I, asphalt-saturated organic felt.

2.4 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO M 288 Class 2.
2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 FOUNDATION DRAINAGE INSTALLATION

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches deep and 12 inches wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

F. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

J. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.3 UNDERSLAB DRAINAGE INSTALLATION

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.

F. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

3.4 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping level and with a minimum cover of 36 inches unless otherwise indicated.
2. Underslab Subdrainage: Install piping level.
3. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of 36 inches unless otherwise indicated.
4. Lay perforated pipe with perforations down.
5. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install thermoplastic piping according to ASTM D 2321.

3.5 PIPE JOINT CONSTRUCTION

A. Join perforated PE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push-on joints.

B. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.6 BACKWATER VALVE INSTALLATION

A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."

B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.

C. Install horizontal backwater valves in piping in manholes or pits where indicated.

3.7 CLEANOUT INSTALLATION

A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."

B. Cleanouts for Foundation and Retaining-Wall Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, **18 by 18 by 12 inches** deep. Set top of cleanout flush with grade.
3. In nonvehicular-traffic areas, use NPS 4 PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, deep. Set top of cleanout 1 inch above grade.
4. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."

C. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.8 CONNECTIONS

A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system.

C. Where required, connect low elevations of foundation subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 221429 "Sump Pumps."

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600

MAYOR JIM GRAY

LEXINGTON

TODD SLATIN
DIRECTOR
CENTRAL PURCHASING

ADDENDUM #1

Bid Number: #95-2017

Date: September 25, 2017

Subject: Construction of Fire Station #24

Address inquiries to:
Sondra Stone
(859) 258-3320

TO ALL PROSPECTIVE SUBMITTERS:

Please be advised of the following clarifications to the above referenced Bid:

1. Bator is an acceptable door manufacturer.
2. The construction site is located in a residential area. It is imperative that the General Contractor and their Sub-Contractors be "good neighbors" and follow all daily clean up procedures as outlined in the construction documents. This includes all SWPP procedures and street cleaning. Additionally, noise permits must be obtained as appropriate. The General Contractor will be held accountable for complaints made regarding the construction site throughout the project.
3. Pre-bid Sign-up sheet is attached.

Todd Slatin

Todd Slatin, Director
Division of Central Purchasing

All other terms and conditions of the Bid and specifications are unchanged.

This letter should be signed, attached to and become a part of your Bid.

COMPANY NAME:_____

ADDRESS: _____

SIGNATURE OF BIDDER: _____

SIGN-IN SHEET
Pre-bid meeting 95-2017 Construction Services for Fire Station #24
September 25, 2017 @ 9:00 AM

Representative	Company Name	DBE/MBE/WBE/ Veteran	Phone#	Email Address
Sondra Stone	LFUCG		859-258-3320	sstone@lexingtonky.gov
Sherita Miller SM	LFUCG		859-258-3323	smiller@lexingtonky.gov
Shannon Devere	Devere Construction		859-946-4652	Bids@devereconstruction.net
Abby Burke	Marrillia Design + Construction		859-685-0414	jmarrillia@marrillia.com
Tom Finney	Finney Mech		859-621-8153	tom@finneycompany.net
Rob Harris	Nixon Power Services		82-777-8274	rharris@nixonpower.com
Neil Trimble	Prestige Contracting		859-806-0133	neil@prestigecontractingllc.com
Jared Dixon	A-1-A Electric, LLC		859-321-3958	jared.a1aelectric@gmail.com
Eric Storie	L.E. Gregg Associates		859-227-4630	EStorie@LEGregg.com.
Daniel Elswick	The Walker Company		859-585-0972	delswick@thewalkercompany.com
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Joyce Thomas	LFUCG		859-258-3054	
Brandon Slusher	STW Engineers		859.277.8177	brandon.slusher@stweng.com
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Jamshid Baradaran	" "		x 3505	Jbaradaran " "

Pavel	Marchuk	Olympic Construction	N/A	215-485-6988	pavel@olympiconstruction.com
Eric	Chambers	BCI	N/A	859-268-1933	echambers@bciaep.com
Mark	Gotcher	Vulcan Materials		8599409356	gotcherm@vmcmail.com

MAYOR JIM GRAY

LEXINGTON

TODD SLATIN
DIRECTOR
CENTRAL PURCHASING

ADDENDUM #3

Bid Number: #95-2017

Date: October 6, 2017

Subject: Construction of Fire Station #24

Address inquiries to:
Sondra Stone
(859) 258-3320

TO ALL PROSPECTIVE SUBMITTERS:

Please be advised of the following clarifications to the above referenced Bid:

Q&A

1. On Sheet E-301 and in Note 15 it mentions a Detail on Sheet E-402. Upon further inspection, when scrolling through the pages there is no Sheet E-402 and it is not listed on the Drawing Index. **A: The note should say E-502.**

Todd Slatin, Director
Division of Central Purchasing

All other terms and conditions of the Bid and specifications are unchanged.

This letter should be signed, attached to and become a part of your Bid.

COMPANY NAME:_____

ADDRESS: _____

SIGNATURE OF BIDDER: _____