

**PROJECT MANUAL – BID SPECIFICATIONS
VOLUME 3
MEP SPECIFICATIONS**

**MCCASKEY HIGH SCHOOL STADIUM PROJECTS
445 N. Reservoir Street
Lancaster PA 17602**

for

**SCHOOL DISTRICT OF LANCASTER
251 South Prince Street, 3rd Floor
Lancaster, PA 17603**

January 6, 2025

SECTION 22 00 10 - PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL

- A. The requirements of the general conditions, the supplementary general conditions, and the applicable portions of Division 1 shall apply to this section of the specifications.

1.2 SCOPE

- A. Provide and install complete and operating plumbing systems in accordance with these specifications and accompanying contract drawings. This shall include all required labor, materials, equipment, and supervision.
- B. The work shall include but is not limited to the following systems, equipment, materials, and labor for a complete system including the following:
 - 1. New Plumbing Fixtures and Equipment
 - 2. Sanitary Waste, Vent, and Domestic Water Piping
 - 3. New Condensate Drainage System
 - 4. Natural Gas Piping System
 - 5. Demolition

1.3 DEFINITION OF WORK RESPONSIBILITY

- A. All electrical control components including starters required for operation of plumbing equipment whether integral or remote shall be furnished and installed under this Contract. Control wiring for control devices shall be furnished and installed by the Contractor who provides the plumbing equipment. Raceways and fittings shall be furnished and installed by the Electrical Contractor.
- B. Power wiring from panelboard or similar source through all equipment disconnects to motors or heating equipment shall be furnished and installed by the Electrical Contractor.
- C. Equipment disconnect switches, unless otherwise specified or supplied by the equipment supplier as an integral part of the equipment shall be furnished and installed by the Electrical Contractor.
- D. All electrical equipment, components, and wiring furnished and installed under this portion of the specifications shall conform to all requirements of the applicable portions of the electrical specifications.
- E. All structural work needed for support of plumbing equipment or components shall be supplied by this contractor unless noted otherwise.
- F. All concrete pads necessary for the support of plumbing equipment or components shall be supplied by the contractor who provides the plumbing equipment unless noted otherwise.
- G. All access panels in finished walls or ceilings shall be supplied by this contractor for installation by the General Contractor.
- H. If any changes are required in the installation of mechanical and electrical services to any equipment accepted as substitutes to the Basis of Design, the Plumbing Contractor shall be responsible for any additional costs incurred or coordination required.

1.4 RULES AND REGULATIONS

- A. All work shall be performed in accordance with the current adopted rules and regulations of authorities having jurisdiction of the local plumbing codes, the utilities having jurisdiction, 2018 International Plumbing Code,

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2018 International Building Code, 2018 International Mechanical Code, NFPA Codes, PA Uniform Plumbing Code, 2018 International Fire Code, 2018 International Fuel Gas Code.

- B. All work shall be performed in accordance with the rules and regulations of Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration), the Department of Education, and all codes and agencies having jurisdiction.
- C. All construction, design fabrication, tests, rating, and installation shall comply with the rules and regulations of all local, state, or national codes and agencies having jurisdiction over this project. Any costs involved in complying with these rules and regulations shall be included in original bid of this Contractor.
- D. This Contractor shall obtain and pay for all construction and installation permits, certificates, and inspection fees relative to his work. He shall also prepare all specific plans as required by proper authorities before acceptance of the work. Costs incurred in the preparation of such plans shall be included in the Contractor's original bid.

1.5 DRAWINGS

- A. The accompanying drawings are a part of these specifications and are intended to show approximate and relative locations of services and equipment. They shall not be scaled to determine exact positions, locations, and clearances.
- B. Due to the diagrammatic layout and small scale of the drawings, certain piping rises, drops, offsets, valves, and related specialties are not shown. The Contractor shall provide all piping, fittings, valves, and specialties required to insure a complete installation without additional cost to the Owner.
- C. All drawings and specifications pertaining to general construction, plumbing, HVAC, sprinkler, electrical and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to consult other trades, this Contractor shall rearrange his work at his own expense.

1.6 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT, AND MATERIALS

- A. The Contractor shall submit, with a letter of transmittal to the Architect, the quantity of sets of shop drawings specified in Division 1 containing all capacities, performances, features, options, accessories and technical data of all materials and equipment listed herein. All submittals shall be made within 45 days after awarding of the contract.
- B. Refer to Division 1 Specifications.
- C. All rejected, not approved, or revise and resubmit submittals shall be corrected as directed by the Architect and resubmitted in ten (10) sets until approved within (10) days after the original submittal was disapproved. No work involving any materials or equipment covered by shop drawings shall be started until the respective shop drawings are approved.
- D. None of the items listed under Section 1.2 shall be installed until final approval has been given by the Architect.
- E. Identify Project, Contractor, Subcontractor, or supplier, pertinent drawing and detail number and specification section number, as appropriate on shop drawings.
- F. On shop drawings, apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the Work and Contractor Documents.
- G. On shop drawings, provide space for Contractor and Architect/Engineer review stamps.
- H. Contractors shall include with each submittal/shop drawing, a matrix outlining all items that do not match the specified unit. If an item is not listed on the matrix, the submitted unit will be assumed to meet all parts of the

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specification. Contractors will be responsible to ensure the specifications are met in full. Items in matrix shall include scheduled performance data vs submitted performance data, specified components vs submitted unit components, specified construction weight, warranty, etc. vs submitted construction, weight, warranty, etc.

1.7 COORDINATION OF WORK

- A. Contractor shall coordinate his work with that of other trades. In case of interference or problems the Architect shall decide which work is to be relocated, regardless of which is installed first.

1.8 LOCATION OF EQUIPMENT

- A. All locations of plumbing equipment and pipe connections there to shall be verified by the Owner and Architect. The contractor shall verify locations sufficiently in advance of the installation to allow uninterrupted progress of the work of all trades.
- B. The Contractor shall prepare dimensioned arrangement drawings at a scale of (1/4" = 1'-0"). Layouts represented by these drawings shall be coordinated with all other trades.
- C. This contractor shall obtain approval of all arrangement drawings before continuing his work.

1.9 MATERIALS AND EQUIPMENT

- A. All materials and equipment, unless otherwise specified, shall be new and of the best quality, approved for their specific application
- B. This Contractor shall provide, when required by the Architect, labeled samples of materials to be used on the project. Samples shall be submitted for approval by the Architect prior to their installation. Provide submittals with color selection charts as applicable.
- C. All materials and equipment installed by the Contractor shall be securely and rigidly supported from or attached to the building structure.

1.10 WORKMANSHIP

- A. All workmanship shall be done according to the best practices of the trade by qualified and competent tradesmen.

1.11 PROTECTION OF EQUIPMENT

- A. The Contractor shall protect all material and equipment from damage until final acceptance as installed. He shall close all openings during construction with temporary plugs and replace all damaged items with ones of exact sameness at his expense.
- B. He shall schedule material and systems for delivery in such a pattern that critical pieces of equipment may be stored within the building, protected from weather. Where materials are stored outside, they must be protected from the elements, damage, theft, and vandalism.
- C. This Contractor shall be responsible for coordinating the procurement of specified materials and equipment being supplied by his sub-contractors and suppliers.

1.12 SCAFFOLDING AND HOISTING

- A. The Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install his systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.

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- B. Contractor shall hoist or rig his own material and equipment into place or arrange for the rigging of it by others at his expense.

1.13 FOREMAN

- A. Contractor must provide a competent Foreman, subject to approval of the Architect. The Foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours.
- B. Any instructions or notices given to the Foreman shall have the same force as if given to the Contractor in person.

1.14 EXCAVATION AND BACKFILL

- A. The Contractor shall do all excavation and backfilling and all shoring, sheeting, pumping, and other work incidental to excavating as required for his installation.
- B. Backfill shall be made with clear earth free from rocks, frozen earth, debris, or other foreign materials. Backfill shall be deposited in uniform layers of not over 8" thick and each layer shall be mechanically tamped before the next layer is applied.
- C. All excavated material remaining after the backfilling operation shall be removed from the site by this Contractor.
- D. Any settlement in trench backfill shall be brought to grade, and damage to pavement or slabs caused by such settlement shall be repaired at the Contractor's expense.
- E. All ditching, pumping, canvas covers, and other methods required to protect and keep all excavation and trenches free from water at all times during the construction period shall be furnished, installed, and maintained by the Contractor.
- F. If the trench bottom becomes muddy, all mud shall be removed and replaced by bankrun sand and gravel or other suitable material as approved by Architect and compacted to the density of the surrounding undisturbed soil. Bottom of trench shall be protected against frost or freezing. This Contractor shall provide adequate shoring to protect his and other workmen. Shoring shall be maintained until tests of lines is completed.
- G. Trenches that pass under paving or roads and have less than 2' of cover, shall have a load-relieving slab over the pipe. Trenches which pass under or within 18" of any wall foundation shall be backfilled with concrete mixes 1-part cement, 3-parts sand, and 5-parts coarse aggregate.
- H. All repair of macadam or concrete paving made necessary by work done under this contract shall be performed by the General Contractor at the expense of this contractor. All such repairs shall match surrounding paving in materials and workmanship.

1.15 PAINTING

- A. All exposed piping, iron work, and equipment installed under this contract shall be painted (1) prime coat and (2) coats of best quality oil paint of color as selected by the Architect.
- B. Unless specifically noted, insulation and piping in ceiling cavity area shall not be painted.

1.16 CUTTING AND PATCHING

- A. This Contractor shall be responsible for all cutting and patching required for installation of work on this project. Cutting and patching methods shall conform to the requirements for new construction contained in other sections of this specification.
 - 1. Patching in surfaces that will remain visible when the project is finished shall be identical in appearance to the undisturbed surface.

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2. Patches in fire rated walls, ceilings and floors shall maintain the fire rating of these barriers by use of approved materials including special fire rated sealing compounds or materials identical to the barrier materials. Refer to the Architectural Specifications for approved methods and materials.
3. Any patching not deemed suitable by the Architect will be replaced by the Owner at the expense of the related contractor.

1.17 WORK SEQUENCE

- A. Refer to Architectural Drawings and Specifications for Phasing Requirements for this Project. This Contractor shall plan and coordinate his work in accordance with those requirements.

1.18 CLEANING

- A. Upon completion of the installation, thoroughly purge all piping of all obstructions and scale and adequately flush all liquid carrying piping to assure a clean system.
- B. Wash all fixtures with soap and water, remove labels and protective covering and clean all grease and cutting from plates or polished piping and trim.
- C. Where damage to finish, furnishing or parts of the building results from pipe stoppage or from failure to clear and flush piping systems properly, the Contractor shall, at his own expense, employ qualified skilled labor to make repairs.

1.19 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall prepare for the Owner, (3) hard bound volumes, each containing all operating instructions and information necessary for the care and maintenance of the system. These volumes shall be complete in every respect and shall include detailed operating instructions for each piece of equipment and diagrams for control wiring and piping so arranged and detailed that the maintenance staff may trace the control in event of operational malfunctioning.
- B. The Contractor shall submit (1) of the hard-bound volumes to the Architect for approval prior to presenting same to Owner.
- C. Printed instructions covering the operation and maintenance of each item of equipment shall be posted at locations designated by the Architect.
- D. The Contractor shall provide Project Records Documents in accordance with requirements of Division 1.

1.20 CLEANING AND FINISHING

- A. After all tests have been made and the system proven satisfactory to the Architect, the Contractor shall go over the entire project, clean all equipment and material installed by him, and leave in a clean and working condition.

1.21 INSTRUCTION OF EMPLOYEES

- A. At the completion of the work this Contractor shall instruct the employees who shall have charge of the equipment in the care, adjustment, and operation of all parts of the system.
- B. At the time designated by the Architect, the equipment manufacturer's engineer shall instruct representatives of the Owner in the operation and maintenance of the equipment.

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1.22 GUARANTEE

- A. All work done under these contracts shall be guaranteed by the respective contractors against defective materials and faulty workmanship for a period of (1) year from date of acceptance by the Owner.
- B. During such a period, and before the expiration of each such guarantee, contractor shall agree to make any and all repairs, adjustments, or replacements which may become necessary, owing to initial settlement or shrinkage, defective material, workmanship, or installation. Contractor shall perform all routine maintenance in accordance with the equipment manufacturer's requirements after 8 months from substantial completion
- C. He shall further agree to provide all labor and material which may be required and to restore to its original condition any adjacent work that he may disturb in making the necessary repairs, adjustments, or replacements in order to fulfill this guarantee.

1.23 DESCRIPTION OF BASE BID AND ALTERNATE BIDS

- A. Refer to Specification Section 012200 and 012300 for additional information.

PART 2 - EXECUTION

2.1 INSTALLATION

- A. Install equipment to permit removal of components and parts which require periodic replacement or maintenance. Arrange pipes, ducts, and equipment to permit access to valves, gauges, starters, motors, doors, and access panels.
- B. Provide access panels in equipment, ducts, etc. as required for inspection and maintenance.

2.2 PIPING INSTALLATION

- A. In general, piping shall be exposed in equipment rooms, and concealed in all finished rooms. Where piping is exposed, it shall be run to allow maximum headroom consistent with proper pitch. No piping or ductwork shall cross below the head of any window or door.
- B. Exposed piping, ducts, conduits, and/or appurtenances indicated on the inside of buildings, shall be installed parallel to the building lines. All piping shall be kept as close as possible to the ceilings and walls, and columns, to take up the minimum amount of space.
- C. All work shall be arranged and installed as high as possible to prevent obstruction of window areas, and to give adequate clearance and access for operation and maintenance.

2.3 SLEEVES

- A. Where pipes or ducts pass through concrete or masonry walls or concrete floors, they shall be protected through the full depth of the construction with galvanized sleeves; same to be at least one size larger than the pipe or duct plus insulation.
- B. Where sleeves occur in concrete floors, the top of sleeve shall be flush with finished floor line, and the end shall be filed to a smooth round finish.
- C. This Contractor shall supply all pipe sleeves and shall inform general contractor of exact sleeve locations in time for their incorporation onto the concrete forms or masonry work.
- D. Any cutting and patching in masonry or concrete made necessary by failure to adequately coordinate with the general contractor shall be done by the General Contractor at his expense.

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- E. The space between pipes/ducts and sleeves shall be caulked airtight with a non-combustible inorganic material.

2.4 UNIONS

- A. Unions shall be provided at all connections to each piece of equipment and on both sides of all automatic valves, and devices which requires removal for maintenance. No unions are to be placed in a location which will be inaccessible after the completion of the project.
- B. Unions of copper tubing shall be 200 lbs. SWP brass ground joint.
- C. Unions for steel pipe shall be 250 lbs. SWP, malleable iron with brass to iron seat.

2.5 CLEARANCE

- A. All piping, including valves and fittings shall be installed to provide the following minimum clearances between the finish coverings, adjacent pipe and/or conduits: 2" between for piping services and 6" between piping services and electrical conduits.

2.6 INCREASES AT ROOF

- A. All soil, vent and waste stacks shall be increased to a minimum of 3" in size immediately before such pipes extend through the roof. All stacks extending through the roof shall finish at least 2' above the roof level.

2.7 SHOCK ABSORBERS

- A. Furnish and install absorbers where shown on the drawings and where required for proper system operation.

2.8 ESCUTCHEON PLATES

- A. All piping passing through walls, ceilings, and floors shall be provided with escutcheon plates securely fastened in place. Where installed on piping in finished areas they shall be chrome plated.

2.9 ACCESS PANELS

- A. Removable panels shall be located to provide easy access to all concealed plumbing accessories that may require adjustments or maintenance, such as valves, water hammer arresters, traps, strainers, cleanouts, or others.
- B. Access panels in finished wall or ceiling surfaces shall be furnished by this Contractor for installation by the General Contractor.
- C. This Contractor shall pay for any work made necessary by his failure to inform other trades of access panel locations.

2.10 APPLICATIONS OF INSULATION AND COVERING

- A. No covering shall be installed by the Contractor until the piping and ducts have been approved by the Architect/ Engineer.

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2.11 PIPING UNDER FLOORS

- A. Wherever piping, conduits and associated materials is run under a floor slab on grade, the work is to be installed after the sub-grade has been brought to the proper level. The work shall then be installed and backfilled, allowed to settle, and refilled before placing crushed stone fill.
- B. Water pipe installed under floor shall be installed in a schedule 40 PVC pipe conduit sleeve.

2.12 INSERTS

- A. Except as noted, provide box type inserts for all hangers and supports intended to suspend piping or light weight equipment from new concrete construction. Fasten all inserts to the form work before concrete is poured. Inserts to be Grinnell Figure No. 282 or Figure No. 279 depending upon the maximum load to be carried.
- B. No toggle bolts, expansion screw anchors or similar imbedded hanger supports shall be used in new construction.

2.13 CHASES AND OPENINGS IN FLOORS AND WALLS

- A. It shall be the duty of the Contractor requiring chases, openings or the placement of any sleeves, anchors, and supports required for his work, whether or not shown on the drawings, to advise the respective Contractors accordingly, prior to or at the time of pouring concrete slabs, beams or the building of walls, etc. He shall furnish all such sleeves, anchors, and supports in place, and all necessary information for the proper location of said chases or openings.
- B. If a contractor shall fail to observe and comply with those requirements, he shall cut, at his own expense, after receiving the consent of the Architect, such chases or openings as may be necessary and proper, providing and building in place all lintels required by these openings, doing the necessary patching and rebuilding of the work required under the direction of the respective Contractors and he shall be responsible for all loss or delay resulting therefrom.

2.14 LUBRICATION

- A. The contractor shall provide all oil for the operation of all equipment until acceptance. The Contractor shall run in all bearings and, after they are run in, drain all oil from the bearings, flush out all bearings, and refill with new oil. The Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance of the equipment. The contractor shall be required to protect all bearings during installation and shall thoroughly grease steel shafts to prevent corrosion. All motors and other equipment shall be provided with covers as required for proper protection during construction.

2.15 JOINTS AND CONNECTIONS

- A. Screwed Connections - All joints made in screwed pipe shall be made with red lead or pipe compound applied to the threaded end of the pipe and not applied within the fitting. Threads shall be cut straight and true with sections reamed and cleaned before installation.

END OF SECTION 22 00 10

SECTION 22 01 00 - PLUMBING GENERAL EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Flexible Pipe Connectors
- B. Pressure Gauges and Pressure Gauge Taps
- C. Thermometers and Thermometer Wells
- D. Pipe and Equipment Hangers and Supports
- E. Equipment Bases and Supports
- F. Sleeves and Seals
- G. Flashing and Sealing Equipment and Pipe Stacks
- H. Nameplates
- I. Tags
- J. Stencils
- K. Pipe Markers
- L. Vibration Isolation

1.2 REFERENCES

- A. ASME - B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element
- B. ASTM E1 - Specification for ASTM Thermometers
- C. ASTM E77 - Verification and Calibration of Liquid-in-Glass Thermometers
- D. UL 393 - Indicating Pressure Gauges for Fire and Protection Services
- E. ASTM F708 - Design and Installation of Rigid Pipe Hangers
- F. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer
- G. MSS SP69 - Pipe Hangers and Supports - Selection and Application
- H. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices
- I. NEMA MG 1 - Motors and Generators
- J. NFPA 70 - National Electrical Code
- K. ASME A13.1 - Scheme for the Identification of Piping Systems

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1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 22 00 10.
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
 - 3. Gauges and Meters: Provide list which indicates use, operating range, total range, and location for manufactured components.
 - 4. Supports and Anchors: Provide manufacturers catalog data including load capacity.
 - 5. Motors: Provide wiring diagrams with electrical characteristics and connection requirements.
 - 6. Mechanical Identification: Provide manufacturers catalog literature for each product required.
 - 7. Vibration Isolation: Provide schedule of vibration isolator type with location and load on each.
- C. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

1.4 REGULATORY REQUIREMENTS

- A. Conform to applicable electrical code.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

1.5 PERFORMANCE REQUIREMENTS FOR PIPING EXPANSION COMPENSATION

- A. Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequate protect system.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

- A. Steel Piping:
 - 1. Manufacturers:
 - a. Flexonics Model 400
 - b. Mason Model BSS
 - c. Keflex Model KFCS
 - 2. Inner Hose: Stainless Steel
 - 3. Exterior Sleeve: Single braided stainless steel
 - 4. Pressure Rating: 200 psig WOG and 250°F
 - 5. Joint: As specified for pipe joints
 - 6. Size: Use pipe sized units
 - 7. Maximum offset: 3/4" on each side of installed center line
- B. Copper Piping:
 - 1. Manufacturers:
 - a. Flexonics Model 300
 - b. Mason Model BBF
 - c. Keflex Model KFCB
 - 2. Inner Hose: Bronze
 - 3. Exterior Sleeve: Braided bronze
 - 4. Pressure Rating: 200 psig WOG and 250°F
 - 5. Joint: As specified for pipe joints
 - 6. Size: Use pipe sized units

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7. Maximum offset: 3/4" on each side of installed center line

2.2 EXPANSION COMPENSATION ACCESSORIES

- A. Pipe Alignment Guides:
 1. Manufacturers:
 - a. Flexonic Model PG
 - b. Keflex Model P
 - c. Metra Flex
 2. Two-piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1" thick insulation, minimum 3" travel.

2.3 PRESSURE GAUGES

- A. Manufacturer: Moeller
- B. Other acceptable manufacturers offering equivalent products:
 1. American
 2. Terice
 3. Weksler
 4. Substitutions: Permitted in accordance with Division 1
- C. Gauge: ASME B40.1, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 1. Case: Steel with brass bourdon tube
 2. Size: 4-1/2"
 3. Mid-Scale Accuracy: 1%
 4. Scale: Both psi and kPa

2.4 PRESSURE GAUGE TAPPINGS

- A. Needle Valve: Brass 1/4" NPT for minimum 150 psig.
- B. Pulsation Damper: Pressure snubber, brass with 1/4" connections.

2.5 STEM TYPE THERMOMETERS

- A. Manufacturer: Moeller.
- B. Other acceptable manufacturers offering equivalent products:
 1. American
 2. Terice
 3. Weksler
 4. Substitutions: Permitted in accordance with Division 1
- C. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
 1. Size: 9" scale
 2. Window: Clear glass
 3. Stem: 3/4" NPT brass
 4. Accuracy: ASTM E77 2%
 5. Calibration: Both °F and °C

2.6 DIAL THERMOMETERS

- A. Manufacturer: Moeller

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- B. Other acceptable manufacturers offering equivalent products:
 - 1. American
 - 2. Terice
 - 3. Weksler
 - 4. Substitutions: Permitted in accordance with Division 1
- C. Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 - 1. Size: 3-1/2" diameter dial
 - 2. Lens: Clear glass
 - 3. Accuracy: 1%
 - 4. Calibration: Both °F and °C.

2.7 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3" outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.8 TEST PLUGS

- A. Test Plug: 1/4" or 1/2" brass fitting and cap for receiving 1/8" outside diameter pressure or temperature probe with Nordel core for temperatures up to 350°F.
- B. Test Kit: Carrying case, internally padded and fitted containing one (1) 2-1/2" diameter pressure gauges, 1-gauge adapters with 1/8" probes, two 1" dial thermometers.

2.9 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 - 1. Grinnell
 - 2. Other acceptable manufacturers offering equivalent products.
 - a. or accepted substitute
- B. Plumbing Piping - DWV:
 - 1. Conform to ASTM F708, MSS SP58, MSS SP69, MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2" to 1-1/2": Malleable iron adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2" and Over: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Wall Support for Pipe Sizes to 3": Cast iron hook.
 - 6. Wall Support for Pipe Sizes 4" and Over: Welded steel bracket and wrought steel clamp.
 - 7. Vertical Support: Steel riser clamp.
 - 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- C. Plumbing Piping - Water:
 - 1. Conform to ASTM F708, MSS SP58, MSS SP69, MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2" to 1-1/2": Malleable iron adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2" and Over: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2" to 4": Carbon steel, adjustable, clevis.
 - 5. Hangers for Hot Pipe Sizes 6" and Over: Adjustable steel yoke, cast iron roll, double hanger.
 - 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6" and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
 - 8. Wall Support for Pipe Sizes to 3": Cast iron hook.

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9. Wall Support for Pipe Sizes 4" and Over: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6" and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast-iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4": Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6" and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.10 PIPE HANGER ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.11 INSERTS

- A. Manufacturers:
 1. Grinnell
 2. Other acceptable manufacturers offering equivalent products.
 - a. or accepted substitute.
- B. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.12 FLASHING

- A. Metal Flashing: 26-ga galvanized steel.
- B. Metal Counterflashing: 22-ga galvanized steel.
- C. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- D. Caps: Steel, 22-ga minimum; 16-ga at fire resistant elements.

2.13 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18-ga galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18-ga galvanized steel.
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Sleeves for Rectangular Ductwork: Galvanized steel.
- E. Firestopping Insulation: Glass fiber type, non-combustible.
- F. Sealant: Acrylic.

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2.14 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2" diameter.
- B. Chart: Typewritten letter size list in anodized aluminum frame. Room numbers shall correspond to Owners room numbering system.

2.15 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4" to 1-1/4" Outside Diameter of Insulation or Pipe: 8" long color field, 1/2" high letters.
 - 2. 1/2" to 2" Outside Diameter of Insulation or Pipe: 8" long color field, 3/4" high letters.
 - 3. 2-1/2" to 6" Outside Diameter of Insulation or Pipe: 12" long color field, 1-1/4" high letters.
 - 4. 8 to 10" Outside Diameter of Insulation or Pipe: 24" long color field, 2-1/2" high letters.
 - 5. Over 10" Outside Diameter of Insulation or Pipe: 32" long color field, 3-1/2" high letters.
- B. Stencil Paint: Semi- gloss enamel, colors conforming to ASME A13.1.

2.16 PIPE MARKERS

- A. Color: Conform to ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6" wide by 4 mil thick, manufactured for direct burial service.

2.17 ROOF PIPE PORTAL ASSEMBLY

- A. Provide roof pipe curb assembly as manufactured by Pate Co. Style PCA or approved substitute.
- B. Pipe curb assembly shall be constructed of insulated galvanized steel curb with 2" wood nailer, plastic cover and graduated neoprene boots with stainless steel clamps.
- C. Provide pipe curb assembly for piping that penetrates roof membrane.

2.18 FIRE STOPPING

- A. Acceptable Manufacturer:
 - 1. EGS Nelson Firestop Product
 - 2. 3M
 - 3. Accepted substitute
- B. Products:
 - 1. Nelson ES1399 Elastomeric Sealant: Water based acrylic latex, endothermic fire protective sealant. It is used for applications of through firestop penetrations and in construction joints. It is available in two grades, N/S (Non-Sag) for wall and overhead installations, and S/L (Self-Leveling) for floor installations.
 - 2. Nelson WRS+ Firestop Wrap Strips: To be used as a wraparound PVC type pipe. After the pipe is covered with the correct number of wraps the WRS+ is covered with a field cut and fabricated collar cover used in conjunction with CLK or FSP which provide a smoke seal.

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3. Nelson PCS Pipe Choke System Collars: To be used on PVC type pipes and conduits to produce an immediate smoke and fire seal. Each PCS is pre-filled with a highly intumescent pliable putty material. Collars are furnished in exact sizes from 1.5" to 4". Collars are UL System Classified for through penetrations of drywall or concrete/masonry assemblies.
4. Nelson LBS+ Firestop Latex Based Sealant: A one part "Latex-Water Based" Intumescent caulk that is of a non-sag formulation for use in all applications, wall, floor and overhead.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Piping Expansion Compensation:
 1. Install in accordance with manufacturer's instructions.
 2. Construct spool pieces to exact size of flexible connection for future insertion.
 3. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
 4. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
 5. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
 6. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where indicated.
 7. Provide expansion loops as indicated on drawings.
- B. Gauges and Meters:
 1. Install positive displacement meters with isolating valves on inlet and outlet. Provide full line size valved bypass with globe valve for liquid service meters.
 2. Install pressure gauges with pulsation dampers. Provide needle valve to isolate each gauge. Extend nipples to allow clearance from insulation.
 3. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
 4. Install thermometers in air duct systems on flanges.
 5. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
 6. Locate duct mounted thermometers minimum 10' downstream of mixing dampers, coils, or other devices causing air turbulence.
 7. Coil and conceal excess capillary on remote element instruments.
 8. Provide instruments with scale ranges selected according to service with largest appropriate scale.
 9. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45° off vertical.
 10. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
 11. Locate test plugs adjacent thermometers and thermometer sockets, pressure gauges and pressure gauge taps, and where indicated.
- C. Mechanical Identification:
 1. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
 2. Install tags with corrosion resistant chain.
 3. Apply stencil painting in accordance with industry standards.
 4. Install plastic pipe markers in accordance with manufacturer's instructions.
 5. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
 6. Install underground plastic pipe markers 6 to 8" below finished grade, directly above buried pipe.
 7. Identify air handling units, heat pump, pumps, heat transfer equipment, tanks, and water treatment devices with stencil painting. Small devices, such as in-line pumps, may be identified with tags.
 8. Identify control panels and major control components outside panels with plastic nameplates.
 9. Identify thermostats relating to terminal boxes or valves with nameplates.
 10. Identify valves in main and branch piping with tags.

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11. Identify air terminal units and radiator valves with numbered tags.
 12. Tag automatic controls, instruments, and relays. Key to control schematic.
 13. Identify piping, concealed or exposed with plastic pipe markers. Use tags on piping 3/4" diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20' on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
 14. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
 15. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
 16. Provide Valve Identification Chart. Post framed chart in Boiler Room.
- D. Vibration:
1. Install isolation for motor driven equipment.
 2. Bases:
 - a. Set steel bases for 1" clearance between housekeeping pad and base.
 - b. Set concrete inertia bases for 2" clearance between housekeeping pad and base.
 - c. Adjust equipment level.
 3. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim
 4. Connect wiring to isolated equipment with flexible hanging loop.
 5. All vibration isolation devices, including steel bases and pouring forms, shall be supplied by a single manufacturer.
 6. All piping located in Mechanical Rooms or Boiler Rooms shall be isolated from the building structure by means of spring hangers.
 7. Bases for all end suction pumps shall be sized to include supports for the suction and discharge elbows.
 8. Flexible conduit shall be used for all electrical connections to isolated equipment. Flexible conduit shall be 50% longer than the actual distance between the rigid conduit and the equipment electrical connection locations.
 9. The schedule of isolators required shall be as follows: Pumps - inertia bases, 2" (minimum) deflection springs.
 10. Spring hangers for piping shall consist of clevis type hangers with spring hanger similar to Grinnell Fig. 247 or Fig. B-268 installed in threaded rod.
- E. Inserts:
1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4".
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- F. Pipe Hangers and Supports:
1. Support horizontal piping as scheduled.
 2. Install hangers to provide minimum 1/2" space between finished covering and adjacent work.
 3. Place hangers within 12" of each horizontal elbow.
 4. Use hangers with 1-1/2" minimum vertical adjustment.
 5. Support horizontal cast iron pipe adjacent to each hub, with 5' maximum spacing between hangers.
 6. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 8. Support riser piping independently of connected horizontal piping.
 9. Provide copper plated hangers and supports for copper piping.
 10. Design hangers for pipe movement without disengagement of supported pipe.
 11. Provide additional supports for heavy valves and specialties and provide sway bracing where needed.

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12. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
13. Insulation protection saddles shall be installed at all pipe hangers and supports for insulated lines. Saddles shall be rolled with a radius to suit the insulation O.D. Saddles shall be #16-ga galvanized steel and shall be 8" long.

G. Equipment Bases and Supports:

1. Provide housekeeping pads of concrete, minimum 4" thick and extending 4 inches beyond supported equipment except pads in Boiler Room shall be 12" deep.
2. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
3. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
4. Provide rigid anchors for pipes after vibration isolation components are installed.

H. Flashing:

1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
2. Flash vent and soil pipes projecting 3" minimum above finished roof surface with lead worked one 1" minimum into hub, 8" minimum clear on sides with 24" x 24" sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.
3. Flash floor drains in floors with topping over finished areas with lead, 10" clear on sides with minimum 36 x 36" sheet size. Fasten flashing to drain clamp device.
4. Seal floor, shower and mop sink drains watertight to adjacent materials.
5. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.
6. Provide curbs for mechanical roof installations 12" minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counter-flashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
7. Adjust storm collars tight to pipe with bolts, caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

I. Sleeves:

1. Set sleeves in position in formwork. Provide reinforcing around sleeves.
2. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
3. Extend sleeves through floors 1" above finished floor level. Caulk sleeves.
4. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
5. Install chrome plated steel escutcheons at finished surfaces.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Section 220010 and in accordance with the requirements of the Commissioning Agent.

3.3 SCHEDULES

- A. Supports and Hangers:

PIPE SIZE <u>Inches</u>	MAX. HANGER SPACING (FT)		HANGER ROD DIAMETER
	<u>Horizontal</u>	<u>Vertical</u>	<u>Inches</u>
1/2 to 1-1/4	6	10	3/8
1-1/4 to 2	10	10	3/8
2-1/2 to 3	10	10	1/2
4 to 5	10	10	5/8
6	10	10	3/4
8 to 12	10	10	7/8
14 and Over	10	10	1
PVC (All Sizes)	4		3/8
C.I. Bell and			

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Spigot (or No-Hub) 5
and at Joints

15

3/4

END OF SECTION 22 01 00

SECTION 22 02 50 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping Insulation
- B. Jackets and Accessories
- C. Equipment Insulation
- D. Covering
- E. Insulation Jackets

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)
- B. National Fire Protection Association (NFPA)
- C. Underwriters Laboratories (UL)
- D. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
- E. ASHRAE Standard 90A-1980

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 22 00 10.
- B. Product Data: Provide product description, list of materials and thickness for each service, and locations.

1.4 QUALITY ASSURANCE

- A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, UL 723.

PART 2 - PRODUCTS

2.1 PIPING

- A. Manufacturers:
 - 1. Owens-Corning
 - 2. Johns Manville
 - 3. Certainteed
 - 4. Armstrong
 - 5. PPG

2.2 DOMESTIC WATER PIPING INSULATION

- A. All domestic hot and cold-water pipes, fittings, flanges, and valves shall be insulated with heavy density fiberglass insulation similar to Owens/Corning Fiberglass 24ASJ/SSL pipe insulation or equal with all service jacket, self-sealing lap and UL listed. Insulation shall have flame spread rating of 25 or less when tested by ASTM E-84 method..

2.3 STORM AND CONDENSATE WATER PIPING

- A. All aboveground interior storm water including roof drain bodies, (excluding overflow storm drainage), and condensate pipes and fittings shall be insulated with nominal 1" wall thickness heavy density fiberglass insulation similar to Owens/Corning Fiberglass 24ASJ/SSL pipe insulation or equal with all service jacket, self-sealing lap and UL listed. Insulation shall have flame spread rating of 25 or less and a maximum smoke developed rating of 50 when tested by ASTM E-84 method.
- B. Optional pipe insulation shall be 1" thick Armaflex insulation. (Concealed areas only).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping, equipment, materials, have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. On exposed piping, locate insulation and cover seams in least visible locations.
- C. Insulated pipes and equipment conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory applied, or field applied.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
 - 3. PVC fitting covers shall be used.
 - 4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
 - 5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- D. For insulated pipes and equipment conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with vapor barrier, factory applied, or field applied.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
 - 3. PVC fitting covers shall be used.
- E. For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- F. Cover hydrous calcium silicate insulation or Fiberglass Industrial Insulation Board with metal mesh and finish with heavy coat of insulating cement.
- G. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
- H. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.

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- I. For exterior applications, provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
- J. Insulation including finishes and adhesive on the exterior surfaces of ducts and equipment shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less as determined by an independent testing laboratory in accordance with NFPA 255-1972 as required by NFPA 90A. Smoke development rating for pipe insulation shall not exceed 50.
- K. Plumbing piping shall be insulated with thickness of insulation indicated below:
 - 1. CW Pipe
 - a. Up to 1-1/2" pipe size – 0.5"
 - b. 1-1/2" to 4" pipe size – 1.0"
 - 2. Hot Water/HW Recirc:
 - a. Up to 1-1/2" pipe size – 1.0"
 - b. 1-1/2" to 4" pipe size – 1.5"

END OF SECTION 22 02 50

SECTION 22 04 10 - PLUMBING PIPING & SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings
- B. Valves
- C. Sanitary Sewer Piping System
- D. Domestic Water Piping System
- E. Cleanouts
- F. Hydrants
- G. Natural Gas Piping Systems
- H. Condensate Piping Systems
- I. Water Hammer Arresters
- J. Backflow Preventers
- K. Hose Bibbs
- L. Washing Machine Boxes

1.2 REFERENCES

- A. ANSI B31.1 - Power Piping
- B. ASME - Boiler and Pressure Vessel Code
- C. ASME B16.3 - Malleable Iron Threaded Fittings
- D. ASME B16.18 - Cast Bronze Solder-Joint Pressure Fittings
- E. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings
- F. ASME B16.23 - Cast Copper Alloy Solder-Joint Drainage Fittings - DWV
- G. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
- H. ASTM A47 - Ferritic Malleable Iron Castings
- I. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
- J. ASTM A74 - Cast Iron Soil Pipe and Fittings
- K. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses

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- L. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
- M. ASTM B32 - Solder Metal
- N. ASTM B88 - Seamless Copper Water Tube
- O. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings
- P. ASTM D3033 - Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- Q. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- R. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- S. AWWA C111- Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings
- T. AWWA C651 - Disinfecting Water Mains
- U. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems
- V. NFPA 54 - National Fuel Gas Code

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 22 00 10.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, specialties, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

PART 2 - PRODUCTS

2.1 SANITARY SEWER PIPING, BURIED

- A. Cast Iron Pipe: ASTM A74 service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets.
- B. PVC Pipe: ASTM D2729 (if approved by local authority, Schedule 40, solid wall).
 - 1. Fittings: PVC
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
 - 3. Not allowed for kitchen piping upstream of the grease interceptor.

2.2 SANITARY SEWER PIPING, ABOVE GRADE, DRAIN AND VENT

- A. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: ASTM C564, neoprene gasket system.
- B. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Neoprene gaskets and stainless-steel clamp-and-shield assemblies.
- C. PVC Pipe: ASTM D2665 (if approved by local authority) solid wall:
 - 1. Fittings: PVC
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

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3. Not allowed for corridor ceiling plenum.
4. Not allowed for kitchen grease waste piping (drain piping).

2.3 PUMPED SANITARY AND STORM PIPING, ABOVE GRADE

- A. Galvanized steel: Schedule 40 beveled ends, ASTM A53
- B. Joints: Butt welded and flanged
- C. Fittings: Schedule 40 seamless steel, butt weld type, ASTM A234.
- D. Paint all piping with rust inhibiting metal primer and one coat of oil base enamel.

2.4 WATER PIPING, BURIED

- A. Copper Tubing: ASTM B88, Type K, hard drawn.
 1. Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper and bronze.
 2. Joints: ASTM B32, solder, (No-Lead), ASTM B828
 3. NSF 61
- B. Cast Iron Pipe: AWWA C151:
 1. Fittings: Ductile iron, standard thickness.
 2. Joints: AWWA C111, rubber gasket with 3/4" (19 mm) diameter rods.
 3. NSF 61

2.5 WATER PIPING, ABOVE GRADE GROUND

- A. Copper Tubing: ASTM B88, Type L, hard drawn.
 1. Fittings: ASME B16.18, cast bronze or ASTM B16.22 wrought copper and bronze.
 2. Joints: ASTM B32, solder, (No lead) ASTM B828
 3. NSF 61-**G**

2.6 NATURAL GAS PIPING & NATURAL GAS REGULATOR VENT PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53 or A120, Schedule 40 black.
 1. Fittings: ASME B16.3, malleable iron, or ASTM A234, forged steel welding type.
 2. Joints: NFPA 54, threaded or welded to ANSI B31.1 ASME Sec 1.

2.7 GAS PIPING, BELOW GRADE

- A. Steel Pipe: ASTM A53 or A120, Schedule 40 black, seamless.
 1. Fittings: ASTM A234, forged steel welding type, with AWWA C105 polyethylene jacket or double layer, half lapped 10 mil (0.25 mm) polyethylene tape.
 2. Joints: NFPA 54, ANSI B31.1, ASME Sec 1, welded.
- B. Plastic Pipe: ASTM D2513 Polyethylene
 1. Fittings: ASTM A234, forged steel welding type, with AWWA C105 polyethylene jacket or double layer, half lapped 10 mil (0.25 mm) polyethylene tape.
 2. Joints: NFPA 54, ANSI B31.1, ASME Sec 1, welded.
- C. Underground piping shall be installed with at least 36" of cover. Piping through exterior walls shall be encased in protective pipe and vented per Code.
- D. Pipe shall be and be installed in accordance with NFPA, International Gas Code and Gas Company.

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2.8 CONDENSATE PIPING

- A. Copper Tube: ASTM B88, Type L hard drawn.
 - 1. Fittings: ASME B16.23, cast bronze or ASME B16.29, wrought copper.
 - 2. Joints: ASTM B32, solder, Grade 95TA.
- B. PVC Pipe: ASTM D2665 (concealed and above roof areas only) (PVC piping is not permitted in any type of plenum space)
 - 1. Fittings: PVC
 - 2. Joints: ASTM D2855, solvent weld.

2.9 GATE VALVES

- A. Manufacturers:
 - 1. Over 3 inches:
 - a. Nibco
 - b. Crane
 - c. Stockham
 - 2. Iron body, bronze trim, rising stem, handwheel, OS&Y, single wedge, flanged ends.
 - 3. Comply with NSF 61, Section 9.

2.10 BALL VALVES

- A. Manufacturers:
 - 1. Up to and Including 3 Inches:
 - a. Nibco
 - b. Crane
 - c. Stockham
- B. Up to and including 3": Bronze two-piece body, bronze ball, Teflon seats and stuffing box ring, lever handle with balancing stops, conventional port, solder, or threaded ends.
- C. Comply with NSF 61, Section 9.

2.11 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Nibco
 - 2. Crane
 - 3. Stockham
- B. Bronze swing disc, solder, or screwed ends.
- C. Comply with NSF 61, Section 9.

2.12 CLEANOUTS

- A. Manufacturers:
 - 1. Zurn
 - 2. Wade
 - 3. Smith
 - 4. Ancon
- B. Exterior Surfaced Areas: Round heavy-duty dura-coated cast iron body with gas and watertight ABS tapered thread plug and round scoriated cover and frame, cast nickel bronze access frame and non-skid cover.

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- C. Interior Finished Floor: Dura-Coated cast iron, two-piece body with double drainage flange, weep holes, and adjustable nickel-bronze strainer, round with scoriated cover, with gas and water-tight ABS tapered thread plug.
- D. Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless-steel access cover secured with machine screw.
- E. Interior Unfinished Accessible Areas: Threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.13 FLOOR DRAIN (FD-1)

- A. Furnish and install floor drain model Z415 as manufactured by Zurn. Unit shall have durable cast iron body, nickel bronze adjustable strainer and inside caulk outlet. Contractor shall install with deep seal trap. Provide ProSet Trap Seal.

2.14 FLOOR DRAIN (FD-2)

- A. Furnish and install floor drain, Zurn Model Z-525. Unit shall be 10" diameter medium duty, with durable cast iron body with bottom outlet. It shall provide vertical adjustment and be equipped with anti-tilt slotted grate and seepage pan. Contractor shall install with deep seal trap. Provide ProSet Trap Guard Seal or approved equal.

2.15 DEEP SINK FLOOR DRAIN (FS-1)

- A. Deep Sink type floor drain shall be Zurn #Z-1902, 12" square open top drain, 10" depth, Sani-Flor Receptor, deep cast -iron body and wauare slotted light duty grate, with white acid resisting **porcelain enamel interior** and top, complete with white ABS anti-splash interior bottom dome strainer. Furnish with medium duty 1/2 NB top grate (12" square) and anti-splash dome strainer. Contractor shall install with deep seal P-trap.

2.16 WALL HYDRANT (WH-1)

- A. Wall hydrant shall be Zurn #Z1320 encased, non-freeze, anti-siphon, automatic draining for flush installation type with 3/4" solder inlet, bronze casing, nickel-bronze face, brass operating parts, renewable nylon seat, vacuum breaker, and operating key lock. Comply with NSF 61, Section 9. Wall hydrant shall have 1/2 turn ceramic disc cartridge and stainless-HOSE BIBB (HB-1)

2.17 ICE MAKER CONNECTION BOX (IMB-1)

- A. Furnish and install Guy Gray Metal Ice Maker Box Model MIB Series, recessed, white powder-coated ice with lead free brass quarter turn hammer arrester valve.

2.18 WATER HAMMER ARRESTER

- A. Water hammer arresters shall be the Hydra-Rester as manufactured by Sioux Chief Manufacturing Company or equal. Arresters shall be of the piston type with a seamless, Type L copper chamber and have a permanent PSI air change above a two O-ring piston. Units shall be certified and sized by PDI-WH201 and ASSE-1010 and carry an unconditional lifetime of the system warranty. Arresters shall be installed per manufacturer's installation instructions.

2.19 HOSE BIBB (HB-1)

- A. Hose Bibb shall be Zurn-Z1350 encased moderate climate wall hydrant for narrow wall installation. Complete with bronze body, all bronze interior parts replaceable seat washer, screwdriver operated stop valve in

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supply, key operated control valve, and 3/4" solder inlet and 3/4" male hose connection standard. Stainless steel box and hinged cover with operating key lock and "WATER" stamped on cover.

2.20 APPROVED EQUALS

- A. The following are approved equals providing they meet specifications:
 - 1. Drains, Hydrants –Wade, Smith, Zurn, Watts, MiFab

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.
- B. Ream pipe and tube ends. Remove burrs.
- C. Remove scale and dirt inside and outside, before assembly.
- D. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
- I. Establish elevations of buried water piping outside the building to ensure not less than 3' of cover.
- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- K. Provide support for utility meters in accordance with requirements of utility companies.
- L. Install bell and spigot pipe with bell end upstream.
- M. Install valves with stems upright or horizontal, not inverted.
- N. Install unions downstream of valves and at equipment or apparatus connections.
- O. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- P. Install ball valves for throttling, bypass, or manual flow control services.

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- Q. Provide flow controls in water recirculating systems where indicated. Balancing valves shall be similar to Bell & Gossett circuit setter type.
- R. Horizontal drainage lines shall be laid to a uniform pitch of 1/4" per foot, if practical, but in no case less than 1/8" to the foot, except where otherwise specifically detailed on the drawings. Each length of pipe and each fitting shall be inspected for defects before installation. Any defective pipe or fitting damaged during or after installation shall be replaced. Each length of pipe shall be laid to bring the inverts to the required line and grade. No stretch of joints will be allowed. All pipe shall be installed to a true straight line. Piping shall be bedded on firm earth foundation of uniform density carefully shaped to fit the lower section of pipe. Each section of pipe shall have a full bearing along its entire length, except at joints where clearance shall be allowed for making up joints. Any length which shows settlement after laying or which is not in true alignment shall be taken up and reset. Under track or roads, the piping shall be run in a standard weight steel pipe sleeve.
- S. Slope water piping and arrange to drain at low points.
- T. Cleanouts shall be installed where indicated on the drawings and at all bends, angles, upper terminals, and not over 50' apart in any lineal run of piping. All cleanouts shall be accessible.
- U. All horizontal sanitary vent piping shall be sloped a minimum of 1/4" per ft.
- V. All underground sanitary piping shall be minimum 2" size.
- W. Water hammer arrestors shall conform to ASSE 1010.
- X. All changes of directions shall be made with fittings per IPC (International Plumbing Code).
- Y. Provide temperature and pressure relief valves per ANSI Z21.22.

3.3 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed, and clean.
- B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15% of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from outlets and from water entry, and analyze in accordance with AWWA C651.

3.4 OPERATING ADJUSTMENTS

- A. All flush valves shall be adjusted for quiet operation and to pass the required amount of water for the proper flushing action.

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3.5 TEST OF WATER SUPPLYING SYSTEM

- A. At the completion of the work, the water supply system must be tested to do a hydrostatic pressure of 50 pounds over the working pressure but not less than 100 pounds to the square inch.
- B. Any water piping run in chases, in walls, or in any way concealed by structural work must be tested to above pressure and proven tight before the pipes are concealed.

3.6 TESTS OF PLUMBING AND DRAINAGE SYSTEMS

- A. The entire system of soil, waste, drain and vent piping must be tested with water or air, as hereinafter described, and proved tight to the satisfaction of representatives of Architect/Engineer before trenches are backfilled, or fixtures connected. Testing instruments must be furnished by the Plumbing Contractor.
- B. When water is used for testing, the drainage system below ground floor shall be filled with water to top of a vertical section of pipe 10' high (except for clay pipe) temporarily connected to the highest point on the lines to be tested. The water shall be allowed to stand for at least 60 minutes for inspection, after which if the lines prove tight, the water is to be drawn off, connection made with the sanitary sewer and trenches backfilled.
- C. All plumbing and drainage piping above the ground floor line must have the openings plugged where necessary and be filled with water to the level of the main roof or tops of vent pipes. The water shall be allowed to stand for at least 60 minutes for inspection, after which if the lines prove tight, the water is drawn off and the fixtures connected.
- D. When air is used for testing, a pressure of not less than 20" of mercury must be maintained without pressure loss for at least 15 minutes. A mercury column gauge must be used in making air tests.

END OF SECTION 22 04 10

SECTION 22 04 40 - PLUMBING FIXTURES & EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Water Closets
- B. Urinals
- C. Lavatories
- D. Sinks
- E. Mop Basins
- F. Electric Water Coolers
- G. Carriers
- H. Water Heaters
- I. Domestic Hot Water Circulating Pumps
- J. Expansion Tank

1.2 REFERENCES

- A. ANSI/ARI 1010-Drinking Fountains and Self Contained, Mechanically Refrigerated Drinking Water Coolers

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 22 00 10.
- B. Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

PART 2 - PRODUCTS

2.1 WATER CLOSET (WC-1, WC-2)

- A. Furnish and install American Standard Aftwall Water Saver Toilet Model #2257.101. Unit shall be vitreous china with siphon jet action, elongated bowl, 1-1/2" top spud, and bolt caps. Unit shall be supplied with Church #5321.112 open front seat and Sloan Royal 111.-1.6 exposed chrome plated, diaphragm type, escutcheon, integral stop, and vacuum breaker (1.6 gpf) flushometer and carrier. Mount at height as shown on the Architectural Drawings. Water closet (WC-1) shall be ADA compliant.

2.2 URINAL (UR-1, UR-2)

- A. Furnish and install wall mounted urinal. Unit shall be American Standard Washbrook FlowWise 0.5-gpf Ultra High Efficiency Urinal Model #6590.501, Sloan Royal #186-0.5, metal cover flush-valve and wall hanger. Mount at height as shown on the Architectural Drawings.

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- B. Mount UR-1 at handicapped height.

2.3 LAVATORY (LV-1, LV-2)

- A. Furnish and install wall hung American Standard Lucerne Lavatory Model #0356.421. Unit shall be vitreous china with front overflow, back and side splash shields, "D shape bowl and single faucet hole and suitable for concealed arms. Faucet shall be Moen single handle ADA metering faucet model #8884 with aerator and flow restrictor (0.5 gpm), ADA approved. Unit shall be supplied with drain, McGuire #8872 adjustable P-trap, #169 flexible supply pipes and installed with carrier for concealed arms. Mount at height as shown on Architectural Drawings.
- B. Furnish and install with lav-shield as manufactured by Tru-Bro. use tamperproof screws.
- C. Provide lavatory mixing valve, Powers Hydro Guard Series LM495 thermostatic mixing valve (or equal).

2.4 SINK (SK-1)

- A. Furnish and install Eagle stainless-steel two compartment coved corner freestanding sink Model #314-16-2-24 with faucet holes on backsplash on 8" centers or approved equal. Faucets shall be Delta backsplash mount faucet Model 22722LF, heavy duty gooseneck spout, (Swivel Spout), lever blade handles, ¼ turn stops, 1.8-gpm aerator. Sink shall include drain with strainer and tailpiece. Unit shall be supplied with McGuire #169 flexible supply pipes and McGuire #8872 adjustable P-trap.

2.5 WATER COOLER (EWC-1)

- A. Furnish and install wall hung bi-level Halsey Taylor Barrier-Free Water Cooler(s) Model HTHBHVR8BL with capacity to cool at least 8 gph of water entering at 80°F and leaving at 50°F with room temperature of 90°F. Unit shall have built-in pressure regulator and solenoid valve controlled by a front push-button. Cooling tank shall be storage type with capacity of at least 2 pints and be vented, red brass with copper refrigerant coil bonded to exterior and hot tin-dipped after assembly. The refrigerant flow shall be controlled by a capillary tube. The temperature shall be controlled by an adjustable thermostat. Unit shall be furnished and installed with bottle filling station mounted integral to water cooler.
- B. The entire cooler shall be warranted for 5 years. Furnish in stainless steel finish. Entire unit shall be "lead-free". Unit shall meet ADA requirements. Mount at height per Architectural drawings.
- C. Water coolers shall be piped with inline water filter sized for unit. Install filter in accessible location.
- D. Furnish and install with Model #98324C Cane Apron.

2.6 MOP BASIN (MB-1)

- A. Mop receptor shall be Model MSB-2424 as manufactured by Powers Fiat, Skokie, Illinois or equal. Color shall be No. T31 - White Drift. The drain body shall be factory installed stainless steel No. 302 with combination strainer and lint basket. Faucet shall be American Standard Heritage Service sink faucet with Aquaseal valves, renewable seats, 4 arm brass handles, 3/4" threaded hose and spout bucket hook top brace to wall, vacuum breaker, union inlets, adjustable 8" centers, 3/4" female thread, chrome finish. Contractor shall install drain with trap.
- B. Furnish and install with Model #832-AA hose and hose bracket, #889-CC mop hanger and #E-77-AA vinyl bumper guard.
- C. For each mop sink, provide and pipe 2nd faucet beside Mop Sink for connection to chemical cleaning system. Installation shall consist of (2) single faucets, (1) HW, (1) CW each with vacuum breaker and 3/4" thread hose coupling.

2.7 WATER HEATERS (DWH-1)

- A. Furnish and install Lochinvar Shield Water Heater Model SWR150N or approved equal. Having a maximum input rating of 150,000 Btu/Hr, a recovery capacity of 175 gallons per hour at a 100°F rise and shall be operated on natural gas. The water heater shall be capable of full modulation firing down to 20% of rated input with a 5:1 turndown ratio. Check local and state codes for allowance of non-ASME models over 200,000 Btu/hr input.
- B. The water heater shall consist of a direct fired Stainless Steel heat exchanger mounted on top of a glass lined storage tank in a fashion that will reduce the amount of scale build-up that is known to reduce efficiency. The water heater shall have no visible pipes that connect the heat exchanger to the storage tank. There shall be no banding material, bolts, gaskets or "O" rings in the construction of the heat exchanger header. The Stainless Steel combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly. A built-in trap shall allow condensation to drain from the heat exchanger assembly. The water heater shall carry a three (3) year heat exchanger and tank warranty and a one (1) year parts warranty.
- C. Specified "SNA" SHIELD water heater shall bear the ASME "HLW" stamp and shall be National Board listed. The tank shall have a working pressure of 150 psi. The tank shall be glass lined and fired to 1600°F to ensure a molecular fusing of glass and steel. The tank shall be completely encased in high density insulation of sufficient thickness to meet the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The tank shall be fitted with a brass drain valve.
- D. The water heater shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.10.3 test standard for the US and Canada. The water heater shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 standard. The water heater shall be certified for indoor installation. The water heater efficiency shall be verified through third party testing by AHRI and listed in the AHRI Certification Directory.
- E. The water heater shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flare observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The water heater shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating firing rates for maximum efficiency. The water heater shall operate in a safe condition at a de-rated output with gas supply pressures as low as 4 inches of water column.
- F. The water heater shall utilize a 24 VAC control circuit and components. The control system shall have an electronic display for setup, status and diagnostics. All electronic circuitries shall be easily accessed and serviceable from the front of the jacket. The water heater shall be equipped with; a circulating pump; high limit temperature control; ASME certified temperature and pressure relief valve; inlet & outlet water temperature sensors; flue temperature sensor; runtime contacts; alarm contacts; low water flow protection, contacts for louvers, security protection, adjustable pump delay, enable/disable contacts and built-in freeze protection. The control shall have optional capability to communicate via Modbus or BACnet protocol and capability for optional CON-X-US remote connectivity. The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory operation test prior to shipping.
- G. The water heater shall feature the SMART CONTROL platform with pump delay, freeze protection, pump exercise and Start-Up Wizard operating with an LCD display and soft key pad. The water heater shall be equipped with an eight-foot power cord. Supply voltage shall be 120 volt / 60 hertz / single phase.
- H. The water heater shall be installed and vented with a:
 - 1. Direct Vent Sidewall system with a horizontal sidewall termination of both the vent and combustion air. The flue shall be CPVC, Polypropylene or Stainless Steel sealed vent material terminating at the sidewall with the manufacturers specified vent termination. A separate pipe shall supply combustion air directly to the WATER HEATER from the outside. The air inlet pipe may be CPVC, Polypropylene, ABS, Galvanized, Dryer Vent, or Stainless-Steel sealed pipe. The air inlet must terminate on the same sidewall with the manufacturer's specified air inlet cap. The total combined air intake length shall not

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exceed 150 equivalent feet. The total combined exhaust venting length shall not exceed 150 equivalent feet. Foam Core pipe is not an approved material for exhaust piping.

- I. The water heater shall be approved for 180°F operation. The water heater shall have an independent laboratory rating for Oxides of Nitrogen (NO_x) of 20 ppm or less, corrected to 3% O₂. The water heater shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments.
- J. The Firing Control System shall be M9, Direct Spark Ignition with Electronic Supervision.

2.8 DOMESTIC HOT WATER CIRCULATING PUMP (CP-1)

- A. Furnish and install domestic water circulating pumps. The pump shall be all bronze construction for domestic hot water service. The pump shall be of the horizontal, oil-lubricated type, specifically designed and guaranteed for quiet operation. Suitable for 125# working pressure.
- B. The pumps shall have a ground and polished steel shaft with integral thrust collar. The shaft shall be supported by two horizontal sleeve bearings designed to circulate oil. The pumps are to be equipped with a water-tight seal to prevent leakage. Mechanical seal faces to be carbon on ceramic. The motor shall be non-overloading at any point on pump curve.
- C. The motor shall be of the open, drip-proof sleeve-bearing quiet operating, rubber-mounted construction. Motors shall have built-in thermal overload protectors.
- D. Circulator Pump shall be Bell & Gossett Model 1610 or approved equal by TACO or Armstrong. Pump shall have a capacity of 10 GPM at 20' head and shall be 1/6 HP 115V/1Ø.
- E. The system shall be provided with a bronze balancing valve and bronze shutoff valves for flow adjustment and maintenance.
- F. The circulator pumps shall be controlled on/off by the ATC system, refer to specification section 230900.

2.9 EXPANSION TANK (ET-1)

- A. furnish and install an Expansion Tank Model ST-25V by Therm-X-Trol. Tank(s) shall be diaphragm type specifically designed for potable water. Tank shall have an acceptance volume of 10.3 gallons.

2.10 THERMOSTATIC MIXING VALVE (TMV-1)

- A. Basis of Design: Powers IntelliStation 2
- B. Acceptable Substitute: Armstrong Brain
- C. Furnish and install a lead-free digital water temperature control and monitoring system. System shall feature full-color touchscreen interface and be configurable on location. Factory programming adjustments shall not be required.
- D. System shall control water temperature to ±2°F in accordance with ASSE 1017 and resist "temperature creep" during periods of low/zero demand. The control shall be password protected and feature a user-adjustable outlet temperature range of 60°F to 180°F with high and low temperature alerts, and an approach temperature of 2°F.
- E. System shall digitally control and monitor mixed outlet temperature.
- F. The control shall be capable of future integration with the building automation systems through BACnet protocol and feature local and remote temperature alarms. System shall provide monitoring and visibility of mixing valve assets across multiple locations/sublocations. System shall offer the ability to remote temperature control for admin levels. System shall be capable of sending system alerts by text and/or email and prioritizing alerts based on levels of safety and potential liability.

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- G. System offers two user levels for security. The control shall be equipped with secure Wi-Fi protocols WPA2-PSK and WPA2- PEAP-MSCHAPv2.
- H. System shall feature a user-set, high-temperature sanitization mode for thermal disinfection of bacteria and a programmable temperature set back feature to improve energy efficiency.
- I. System shall feature high speed actuator with override feature. In the event of a power failure, system shall open full cold supply. In case of a loss of cold water, the system shall close hot water supply.
- J. System shall be listed/approved to ASSE 1017, cUPC, NSF, UL 60730-1, UL 60730-2-9, IEC 60730, and BTL (BACnet Testing Laboratories).
- K. Systems shall be piped per Manufacturers piping requirements.
- L. System shall be a Powers IS2075VL with a flow of 34 GPM at 5 psi drop with minimum flow demand of 0 GPM.

2.11 FOOD SERVICE FIXTURES

- A. Fixtures provided by Kitchen Supplier and piped by the Plumbing Contractor. All exposed piping shall have chrome finish. See definition of Work Responsibility. Refer to Drawings for Kitchen Equipment Schedule and for additional work.
- B. Plumbing Contractor shall provide all rough-in's and make final connections.
- C. Plumbing Contractor shall supply and install with chrome supplies, traps, valves, etc., for complete installation.
- D. Plumbing Contractor shall provide and install with Powers LM495 thermostatic mixing valve for all hand sink fixtures.

2.12 ACCEPTABLE SUBSTITUTES:

- A. Water Closets, Urinals, Lavatories – American Standard, Zurn, Sloan
- B. Faucets – American Standard, Chicago Faucets, Speakman, Moen Commercial, Delta Commercial, T&S Brass
- C. Flush Valves - Sloan, Zurn, Moen Commercial
- D. Coolers - Elkay, Oasis, Halsey Taylor
- E. Seats - Beneke, Kohler, American Standard, Zurn
- F. Sinks – Eagle or approved equal
- G. Mixing Valves – Powers, Leonard, Symmons, Acorn

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.

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3.2 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install each fixture with trap, easily removable for servicing and cleaning.
- C. Provide chrome plated rigid or flexible supplies to fixtures with stops, reducers, and escutcheons.
- D. Install components level and plumb.
- E. Install and secure fixtures in place.
- F. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07900, color to match fixture.
- G. Solidly attach water closets to floor with lag screws.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

- A. At completion clean plumbing fixtures and equipment.

3.7 PROTECTION OF FINISHED WORK

- A. Protect finished Work.
- B. Do not permit use of fixtures.

3.8 FIXTURE HEIGHTS

- A. Install fixtures to heights above finished floor as indicated on the Architectural Drawings.

END OF SECTION 22 04 40

SECTION 22 08 00 – PLUMBING COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section.
- B. The requirements of this Section apply to all sections of Division 22.
- C. Owner's Project Requirements (OPR) and Basis of Design (BOD) documentation prepared by Owner and Architect contains requirements that apply to this Section.
- D. This project will have selected building systems commissioned.

1.2 SUMMARY

- A. Section Includes:
 - 1. Plumbing Commissioning Description
 - 2. Plumbing Commissioning Responsibilities
 - 3. This Section includes requirements for commissioning HVAC systems, sub-systems, and equipment. This Section supplements the general requirements specified in General Commissioning Requirements in Architectural Specifications.
 - 4. Refer to General Commissioning Requirements in Architectural Specifications for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.
 - 5. Refer to General Commissioning Requirements in Architectural Specifications for definitions.

1.3 REFERENCES

- A. Building Commissioning Association: BCA – Commissioning Handbook
- B. National Environmental Balancing Bureau: NEBB – Procedural Standards for Building Systems Commissioning.

1.4 COMMISSIONING DESCRIPTION

- A. Plumbing Commissioning process includes the following tasks:
 - 1. Testing and start-up of Plumbing equipment and systems.
 - 2. Equipment and system verification checks.
 - 3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
 - 4. Provide qualified personnel to assist in commissioning tests.
 - 5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
 - 6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
 - 7. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
 - 8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
 - 9. Provide training for systems specified in this Section with coordination by Commissioning Authority.
- B. Equipment and Systems to be Commissioned:

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1. New Plumbing Systems that were installed under this Contract including the domestic hot water system.
 - C. Commissioning of a system or systems specified in this Division is part of the construction process. Documentation and testing of these systems, as well as training of the OWNER's Operation and Maintenance personnel, is required in cooperation with the OWNER and the Commissioning Agent.
 - D. Refer to Architectural Specifications for additional information.
- 1.5 COMMISSIONING SUBMITTALS
- A. Draft Forms: Submit draft of system verification form.
 - B. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified.
 - C. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.
 - D. The commissioning process requires review of selected Submittals. The Commissioning Agent will identify, from a list provided by the Contractors, which submittals will be reviewed by the Commissioning Agent.
 - E. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in General Commissioning Requirements in Architectural Specifications.
- 1.6 CLOSEOUT SUBMITTALS
- A. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.
 - B. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.
- 1.7 QUALITY ASSURANCE
- A. Perform work in accordance with BCA requirements.
- 1.8 COMMISSIONING RESPONSIBILITIES
- A. Equipment or System Installer Commissioning Responsibilities:
 1. Attend commissioning meetings.
 2. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
 3. Provide instructions and demonstrations for Owner's personnel
 4. Ensure sub-contractors perform assigned commissioning responsibilities.
 5. Ensure participation of equipment manufacturers in appropriate start-up, testing, and training activities when required by individual equipment specifications.
 6. Develop start-up and initial checkout plan using manufacturer's start-up procedures and functional performance checklists for equipment and systems to be commissioned.
 7. During verification check and start-up process, execute Plumbing related portions of checklists for equipment and systems to be commissioned.
 8. Perform and document completed start-up and system operational checkout procedures, providing copy to Commissioning Authority.
 9. Provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.

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10. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
11. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
12. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
13. Prior to start-up, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for start-up.
14. Provide factory supervised start-up services for equipment and systems. Coordinate work with manufacturer and Commissioning Authority.
15. Perform verification checks and start-up on equipment and systems as specified.
16. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
17. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
18. Conduct Plumbing system orientation and inspection.

B. Testing, Adjusting, and Balancing Agency Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Participate in verification testing, adjusting, and balancing report for verification or diagnostic purposes. Repeat sample of 20% of measurements contained in testing, adjusting, and balancing report as selected by Commissioning Authority.
3. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

1.9 COMMISSIONING MEETINGS

- A. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

1.10 SCHEDULING

- A. Prepare schedule indicating anticipated start dates for the following:
1. Piping system pressure testing.
 2. Piping system flushing and cleaning.
 3. Equipment and system start-ups.
 4. Testing, adjusting, and balancing.
 5. Plumbing system orientation and inspections.
 6. Operation and maintenance manual submittals.
 7. Training sessions.

1.11 COORDINATION

- A. Notify Commissioning Authority minimum of four weeks in advance of the following:
1. Scheduled equipment and system start-ups.
 2. Scheduled start of testing, adjusting, and balancing work.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Place Plumbing systems and equipment into full operation and continue operation during each working day of commissioning.

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- B. Prior to start of functional performance test, install replacement filters in equipment as specified in individual section.

3.2 FIELD TESTS AND INSPECTIONS

- A. Be responsible to participate in initial and alternate peak season test of systems required to demonstrate performance.
- B. Occupancy Sensitive Functional Performance Tests:
 - 1. Test equipment and systems affected by occupancy variations at minimum and peak loads to observe system performance.
 - 2. Participate in testing delayed beyond Final Completion to test performance with actual occupancy conditions.
- C. The Contractor shall complete Systems Readiness Checklists to verify systems, sub-systems, and equipment installation is complete and systems are ready for Systems Functional Testing. The Commissioning Agent will prepare Systems Readiness Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the OWNER and to the Commissioning Agent for review. The Commissioning Agent may spot-check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and re-submission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and re-submission. Refer to General Commissioning Requirements in Architectural Specifications for submittal requirements for System Readiness Checklists, Equipment Startup Reports, and other commissioning documents.
- D. Contractor tests as required by other sections of Division 22 shall be scheduled and documented. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.
- E. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Owner's Representative. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will direct and document the testing. The Contractor shall sign the test reports to verify tests were performed. See General Commissioning Requirements in Architectural Specifications for additional details.
- F. Training of the OWNER operation and maintenance personnel is required in cooperation with the Owner's Representative and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to General Commissioning Requirements in Architectural Specifications for additional Contractor training requirements.

END OF SECTION 22 08 00

SECTION 23 00 10 – MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to all Division 23 Specification Sections.
- B. All references to Mechanical Contractor, HC or MC shall be same as reference to HVAC Contractor.

1.2 SCOPE OF PROJECT

- A. Provide a complete and operating heating, ventilating and air conditioning installation in accordance with these specifications and accompanying contract drawings. This includes all required labor, materials, apparatus, and supervision.
- B. The work shall include but is not limited to the following systems, equipment, materials, and labor for a complete system including the following:
 - 1. Condensing Boilers
 - 2. Flue Vent Piping
 - 3. Hot Water Piping System including Pumps, Piping, etc.
 - 4. Water Treatment Systems
 - 5. Hot Water Cabinet and Unit Heaters
 - 6. Ductwork Systems
 - 7. Diffusers, Registers & Grilles
 - 8. VRF Heat Pump Systems
 - 9. Exhaust Fans
 - 10. ATC Control System
 - 11. Ductless-Split Air Conditioning Systems

1.3 DEFINITION OF WORK RESPONSIBILITY

- A. All electrical control components including starters required for operation of HVAC equipment whether integral or remote shall be furnished and installed under this Contract. Control wiring and accessories for control devices shall be furnished and installed by the Contractor who provides the HVAC equipment.
- B. Conduit, raceways, boxes, and fittings for control wiring shall be installed by an Electrical Contractor licensed per City of Philadelphia requirements. Materials and installation shall be in accordance with applicable Division 26 sections. All wiring shall be plenum rated.
- C. Power wiring from panelboard or similar source through all equipment disconnects to motors or heating equipment shall be furnished and installed by the Electrical Contractor.
- D. Equipment disconnect switches, unless otherwise specified are supplied by the equipment manufacturer as an integral part of the equipment shall be furnished and installed by the Electrical Contractor.
- E. All electrical equipment, components, and wiring furnished and installed under this portion of the specifications shall conform to all requirements of the applicable portions of the electrical specifications.
- F. All base flashing, where required, shall be by others, with necessary counterflashing by this contractor.
- G. All structural work needed for support of mechanical equipment or components shall be supplied by this contractor.

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- H. All concrete pads necessary for the support of HVAC equipment or components shall be supplied by the contractor who provides the HVAC equipment.
- I. All access panels in finished walls or ceilings shall be supplied by this contractor for installation by the General Contractor.
- J. If any changes are required in the installation of mechanical, structural, or electrical services to any mechanical equipment accepted as approved equals, the Mechanical Contractor shall be responsible for any additional costs incurred or coordination required.

1.4 RULES AND REGULATIONS

- A. Perform in accordance with the rules and regulations of the International Building Code (IBC), International Mechanical Code (IMC), National Electrical Code (NEC), National Fire Protection Association (NFPA), International Fire Code (IFC) and other Codes and Standards cited in this specification and the requirements of the utility companies serving the project site.
- B. All work shall be performed in accordance with the rules and regulations of Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration) and any other national, state, or local authority having jurisdiction.
- C. Perform all construction, design, fabrication, tests, rating, and installation in compliance with the regulations of all local, state, or national agencies having jurisdiction over the project. Pay all costs involved in work necessary to comply with these regulations.
- D. The Contractor assumes all responsibility and liability for any code violations, damage or injury which occurs as a result of a deviation from or a change to the requirements of these plans and specifications which has not been approved in writing by the Engineer.
- E. This Contractor shall obtain and pay for all construction and installation permits, certificates, and inspection fees relative to his work. He shall also prepare all specific plans as required by proper authorities before acceptance of the work. Costs incurred in the preparation of such plans shall be included in the Contractor's original bid.
- F. The intent of these drawings and specifications is to define the scope-of-work and standards of quality for the project. The Contractor is responsible for understanding and following the requirements of the codes and standards referenced by these documents. The Contractor shall be responsible for costs associated with changes when a code enforcement official determines that work does not comply with referenced codes and standards.

1.5 DEFINITIONS

- A. General - Basic Contract definitions are included in the Conditions of the Contract.
- B. Indicated - The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.
- C. Directed - Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the Architect, requested by the Architect, and similar phrases.
- D. Approved - The term approved, when used in conjunction with the Architect's action on the Contractor's submittals, applications, and requests, is limited to the Architect's duties and responsibilities as stated in the Conditions of the Contract.
- E. Regulation - The term regulation includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

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- F. Furnish - The term furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. Install - The term install describes operations at the Project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. Provide - The term provide means to furnish and install, complete and ready for the intended use.
- I. Contractor - The Contractor or Electrical Contractor - The term means the Contractor responsible for all work under this Division.
- J. Installer - An installer is the Contractor, or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
1. The term experienced, when used with the term installer, means having a minimum of five previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.
 2. Trades - Using terms such as carpentry is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as carpenter. It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.
 3. Assigning Specialists - Certain Sections of the Specifications require that specific construction activities be performed by specialists who are recognized experts in those operations. The specialists must be engaged for those activities, and their assignments are requirements over which the Contractor has no choice or option. However, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.
 - a. This requirement is not to be interpreted to conflict with enforcing building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.
- K. Project Site is the space available to the Contractor for performing construction activities either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project site is shown on the drawings and may or may not be identical with the description of the land on which the Project is to be built.
- L. Testing Agencies - A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.
- M. AHJ – Authority(ies) Having Jurisdiction
- N. Abbreviations and Names - Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations, as referenced in Contract Documents, are defined to mean the associated names.
1. AAHTO American Association of State Highway and Transportation Officials
 2. ACI American Concrete Institute
 3. AISC American Institute of Steel Construction
 4. AISI American Iron and Steel Institute
 5. ANSI American National Standards Institute
 6. ASTM American Society for Testing and Materials
 7. AWS American Welding Society
 8. CBM Certified Ballast Manufacturers Assoc.
 9. CRSI Concrete Reinforcing Steel Institute
 10. ETL ETL Testing Laboratories Inc.
 11. FM Factory Mutual Research Organization
 12. IMSA International Municipal Signal Association
 13. ISA Instrument Society of America
 14. NEC National Electrical Code
 15. NFPA National Fire Protection Assoc.

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16. UL Underwriters Laboratories, Inc.

- O. Federal Government Agencies - Names and titles of federal government standard- or Specification-producing agencies are often abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard- or Specification-producing agencies of the federal government. Names and addresses are subject to change but are believed to be, but are not assured to be, accurate and up to date as of the date of the Contract Documents.

1. CFR Code of Federal Regulations
2. EPA Environmental Protection Agency
3. FAA Federal Aviation Administration (US Department of Transportation)
4. FCC Federal Communications Commission
5. FS Federal Specification (from GSA); Specifications Unit (WFSIS)
6. MIL Military Standardization Documents (US Department of Defense)
7. Naval Publications and Forms Center
8. OSHA Occupational Safety and Health Administration (US Department of Labor)
9. REA Rural Electrification Administration (US Department of Agriculture)

1.6 DRAWINGS

- A. The accompanying drawings are a part of the contract documents and are intended to show approximate and relative locations of services and equipment. Do not scale drawings to determine exact positions, locations, and clearances.
- B. Due to the diagrammatic layout and small scale of the drawings, certain piping and duct rises, drops, offsets, valves, and related specialties are not shown. The Contractor shall provide all ductwork, piping, fittings, valves, and specialties required to insure a complete installation without additional cost to the Owner.
- C. All drawings and specifications pertaining to general construction, kitchen, plumbing, HVAC, sprinkler, electrical and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to coordinate with other trade, this Contractor shall rearrange his work at his own expense.

1.7 SUBMITTAL OF SHOP DRAWINGS FOR REVIEW

- A. Submit shop drawings with a letter of transmittal to the Architect per requirements of the General Conditions and Architects instructions.
- B. Properly prepare submittals before transmitting to the designated reviewer.
1. Prepare an individual submittal package for each related group of materials.
 2. Refer to individual 230000 Sections for materials to be submitted for review and approval.
 3. Collate all items to be submitted as required by Division 1 consisting of one copy of each item. Permanently bind together by staples or other means all pages in each set.
 4. Bind with each set a typed cover sheet showing the date, project name, project location, Engineer's name, Contractor's name, Specification Section, and an index of all items included.
 5. Provide space on the cover sheet for the approval stamps of the Subcontractor, Contractor, Engineer, and Architect. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
 6. Clearly mark each page in the submittal set to show the manufacturer's name.
 7. When a page shows more than one item or catalog number, mark the item and catalog number which is proposed for use. Show all accessories, options and appurtenances which are required or which the Contractor desires to use.
 8. Improperly prepared submissions will be returned without action.
- C. All disapproved submittals shall be corrected as directed by the Architect/Engineer and resubmit the same quantity as originally submitted until approved. No work involving any materials or equipment covered by shop drawings shall be started until the respective shop drawings are approved.

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- D. All items requiring shop drawing review shall not be installed until final approval has been given by the Architect/Engineer.

1.8 SUBSTITUTIONS

- A. All substitutions must be submitted in accordance with Division 1 requirements.
- B. Substitutions submitted not in accordance with Division 1 requirements will be returned without review.
- C. All costs involved in changes in the building, to the equipment, to the arrangement of equipment, or to the work performed or to be performed under other sections of the specifications, due to the substitution of equipment in lieu of that shown on the drawings or specified, shall be borne by the Contractor making such substitutions, and shall include, but not necessarily be limited to, costs or fees in connection with resubmission of drawings for approval, if required, by the Commonwealth of Pennsylvania, local authorities or insuring agencies having jurisdiction over the work.

1.9 SUBMITTALS FOR CLOSEOUT

- A. Record Drawings: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, Subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the mark-up before enclosing concealed installations.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of cable tray and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Locations of concealed internal utilities.
 - i. Changes made by Change Order.
 - j. Changes made following Architect's written orders.
 - k. Details not on the original Contract Drawings.
 - l. Field records for variable and concealed conditions.
 - m. Record information on the Work that is shown only schematically.
 - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 - 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 - 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
 - 7. Provide one (1) hard copy and one (1) PDF electronic file on digital media acceptable to Architect/Engineer for Owner. Provide one (1) additional PDF electronic file for the Engineer.
- B. O&M Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Enable bookmarking of individual documents based upon file names. Name document files to correspond to system, subsystem, and equipment names used in manual

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directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel upon opening file.

3. Provide two (2) copies of the PDF electronic files on digital media acceptable to Architect/Engineer. One copy shall be for the Owner and the other shall be for the Engineer.

C. The Contractor shall submit 3 copies of the final wiring certificates.

D. The Contractor shall submit a copy of the Project Warranty

1.10 WARRANTY

A. The Contractor shall submit the following guarantee:

1. Written one (1) year full warranty guarantees shall be submitted for the entire mechanical installation installed under this project. The warranty shall begin at substantial completion of the project. If the manufacturer's warranty begins when the equipment ships or is ordered, then the Contractor shall extend the warranty to cover the construction period plus the warranty specified under substantial completion. If the manufacturer's standard guarantee provides for a longer period, the longer period shall apply.
2. Where defects in the material, equipment and/or workmanship become evident within this guarantee period, the Contractor shall be responsible for providing new manufacturer approved material and equipment, and/or correcting the defective workmanship without any costs to the Owner.

B. During such a period, and before the expiration of each such guarantee, contractor shall agree to make any and all repairs, adjustments, or replacements which may become necessary, owing to initial settlement or shrinkage, defective material, workmanship, or installation.

C. He shall further agree to provide all labor and material which may be required and to restore to its original condition any adjacent work that he may disturb in making the necessary repairs, adjustments, or replacements in order to fulfill this guarantee.

1.11 INSPECTION

A. Inspections of mechanical work will be made by an agency hired by the Contractor.

1.12 VISIT TO THE SITE

A. Bids as submitted will be interpreted to include all costs and changes made necessary by such conditions. Refer to the pre-bid meeting schedule in invitation to bid.

1.13 COORDINATION OF WORK

A. Coordination and meetings: Coordinate the installation of all interior and exterior products and systems specified for this construction project including those specified under multiple prime contracts in accordance with Division 1.

B. Coordination with Various Trades: Contractor shall coordinate space and installation requirements of all work, including underground utilities, which is indicated diagrammatically on drawings, with the project manager, respective contractors, and Utility Company's prior to starting any work. In case of interference or problems, the Architect shall decide which work is to be relocated, regardless of which work is installed first, at no additional cost. See Division 1 General Requirements.

C. The Mechanical Contractor shall prepare dimensioned arrangement drawings at a scale of (1/4" = 1'-0") to be utilized by all contractors for coordination. Each contractor shall be required to, and responsible for, adding their respective work to these coordination drawings. Each contractor shall coordinate with all other trades to fit all equipment and materials in allocated space. Completed coordination drawings shall be submitted to Architect/Engineer for review.

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1.14 LOCATION OF EQUIPMENT

- A. All locations of plumbing, HVAC and fire protection equipment and pipe connections there to shall be verified by the Architect/Engineer. The contractor shall verify locations sufficiently in advance of the installation to allow uninterrupted progress of the work of all trades.
- B. This contractor shall obtain approval of all arrangement drawings before continuing his work.

1.15 MATERIAL QUALITY

- A. All materials and equipment, unless otherwise specified, shall be new and of the best quality, approved for their specific application.
- B. This Contractor shall provide, when required by the Architect, labeled samples of materials to be used on the project. Samples shall be submitted for approval by the Architect prior to their installation.
- C. All materials and equipment installed by the Contractor shall be securely and rigidly supported from or attached to the building structure.
- D. Furnish products listed and classified by Underwriters Laboratories, Inc., or other testing firms acceptable to the authority having jurisdiction.

1.16 WORKMANSHIP

- A. Execute all work utilizing qualified and competent employees in a manner consistent with good workmanship. Install all equipment in accordance with Engineer's approved shop drawings and manufacturer's recommendations.
- B. Firmly support and secure to the building construction all materials and equipment. Use only approved hardware and methods as described in these Specifications.

1.17 PROTECTION OF EQUIPMENT AND MATERIALS

- A. Responsibility for care and protection of electrical work rests with Contractor until it has been tested and accepted. Refer also to specific requirements in each section of this specification.
- B. The Contractor shall close all openings during construction with temporary plugs and replace all damaged items with ones of exact sameness at his expense.
- C. The Contractor shall schedule material and systems for delivery in such a pattern that critical pieces of equipment may be stored within the building, protected from weather. Where materials are stored outside, they must be protected from the elements and damage.
- D. This Contractor shall be responsible for coordinating the procurement of specified materials and equipment being supplied by his sub-contractors and suppliers.

1.18 SCAFFOLDING AND HOISTING

- A. The Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install all systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.
- B. Contractor shall hoist or rig his own material and equipment into place or arrange for the rigging of it by others at his expense.

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1.19 FOREMAN

- A. Contractor must provide a competent foreman, subject to approval of the Architect. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours.
- B. Any instructions or notices given to the foreman shall have the same force as if given to the Contractor in person.

1.20 EXCAVATION AND BACKFILL

- A. The Contractor shall provide all excavation and backfilling and all shoring, sheeting, pumping, and other work incidental to excavating as required for his work. Refer to Division 31 & 32.
- B. Backfill shall be made with clear earth free from rocks, frozen earth, debris, or other foreign materials. Backfill shall be deposited in uniform layers of not over 8" thick and each layer shall be mechanically tamped before the next layer is applied.
- C. All excavated material remaining after the backfilling operation shall be removed from the site by this Contractor.
- D. Any settlement in trench backfill shall be brought to grade, and damage to pavement or slabs caused by such settlement shall be repaired at the Contractor's expense.
- E. All ditching, pumping, canvas covers, and other methods required to protect and keep all excavation and trenches free from water at all times during the construction period shall be furnished, installed, and maintained by the Contractor.
- F. If the trench bottom becomes muddy, all mud shall be removed and replaced by bankrun sand and gravel or other suitable material as approved by Architect and compacted to the density of the surrounding undisturbed soil. Bottom of trench shall be protected against frost or freezing. This Contractor shall provide adequate shoring to protect his and other workmen. Shoring shall be maintained until tests of lines is completed.
- G. Trenches that pass under paving or roads and have less than 2' of cover, shall have a load-relieving slab over the pipe. Trenches which pass under or within 18" of any wall foundation shall be backfilled with concrete mixes 1-part cement, 3-parts sand, and 5-parts coarse aggregate.
- H. All repair of macadam or concrete paving made necessary by work done under this contract shall be performed by the Mechanical Contractor at the expense of this Contractor-as required by the specifications. All such repairs shall match surrounding paving in materials and workmanship. Work shall comply with the appropriate sections of the General Specification.
- I. All grading and seeding made necessary by work done under this contract shall be performed by the Mechanical Contractor as required by the specifications. Work shall comply with the appropriate sections of the General Specifications.
- J. All excavation is unclassified unless otherwise noted on the drawings or in Division 31 of the Specifications.
- K. Provide warning tape above all underground services, properly identifying each type of service.

1.21 PAINTING

- A. All exposed piping, iron work, and equipment installed in the mechanical equipment rooms under this contract shall be painted by the installing contractor with 1 prime coat and 2 coats of best quality oil paint of color as selected by the Architect.
- B. Unless specifically noted, insulation and any galvanized piping in ceiling cavity area shall not be painted.

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- C. All grilles, louvers, etc. unless otherwise indicated shall be either furnished in or painted in a color selected by the Architect. When requested by the Architect, the equipment shall be finished with a prime coat and then professionally painted in the field in a color selected by the Owner. The Mechanical Contractor shall assume responsibility for all costs involved.
- D. Factory painted and galvanized finishes which are damaged before the Owner occupies the building shall be repaired with matching paint or cold galvanizing compound respectively. Touch-up of factory finishes shall be done by the Mechanical Contractor.

1.22 CUTTING AND PATCHING

- A. This Contractor shall be responsible for all cutting and patching required for demolition or installation of work on this project. Cutting and patching methods shall conform to the requirements for new construction contained in other sections of this specification.
 - 1. Patching in surfaces that will remain visible when the project is finished shall be identical in appearance to the undisturbed surface.
 - 2. Patches in fire rated walls, ceilings and floors shall maintain the fire rating of these barriers by the use of approved materials including special fire rated sealing compounds or materials identical to the barrier materials. Refer to the Architectural Specifications for approved methods and materials.
 - 3. Any patch work not deemed suitable by the Architect, Owner or CM will be replaced at the expense of the related Contractor.
 - 4. Refer to Division 1 for additional requirements.
 - 5. Refer to Specification Section 23100 for firestopping materials.

1.23 WORK SEQUENCE

- A. Refer to Architectural Drawings and Specifications for Phasing Requirements for this Project and the approved Contractors Phasing Schedule. This Contractor shall plan and coordinate his work in accordance with those requirements. Provide any and all temporary valves, pipe, vents, systems, etc. as required to keep the occupied areas in service and maintained by the respective contractor.
- B. Mechanical Contractor shall provide temporary piping, insulation, valves, etc. as required to keep systems operational during the phased construction project.

1.24 CLEANING AND FINISHING

- A. After all tests have been made and the system proven satisfactory to the Architect, the Contractor shall go over the entire project, clean all equipment and material installed by him, and leave in a clean and working condition.
- B. Upon completion of the installation, thoroughly purge all piping of all obstructions and scale and adequately flush all liquid carrying piping to assure a clean system.

1.25 PERFORMANCE OF EQUIPMENT

- A. Provide materials, equipment, and appurtenances of any kind, shown on the drawings, hereinafter specified, or required for the completion of the work in accordance with the intent of these specifications, which are completely satisfactory and acceptable in operation, performance, and capacity. Approval, either written or verbal, of any drawings, descriptive data or samples of such material, equipment, and/or appurtenance does not relieve the Contractor of his responsibility to turn over the same to the Owner in perfect working order at the completion of the work.
- B. Replace any materials, equipment, or appurtenances, the operation, capacity, or performance of which does not comply with the drawings and/or specification requirements or which is damaged prior to acceptance by the Owner with proper and acceptable items in working order, satisfactory to the Engineer and Architect without additional cost to the Owner.

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1.26 ACCESS

- A. Furnish and erect all scaffolding and ladders required in the installation of wiring, equipment, and fixtures.

1.27 INSERTS

- A. Where desired in cast in place concrete, provide and install inserts of an approved type. Where two or more parallel conduits are installed, continuous inserts may be used. Where required to distribute the load on the inserts, install a piece of reinforcing steel of sufficient length through the inserts.

1.28 SLEEVES

- A. Furnish to the General Contractor sleeves and locations where work of this contract must pass through new walls, floors, ceilings, roofs, and other construction. Extend each sleeve through the floor, wall or partition and cut flush with each surface unless otherwise required.
- B. For sleeves in bearing and masonry walls, floors, and partitions provide standard weight steel pipe finished with smooth edges. For other than masonry partitions, through suspended ceilings, and for concealed vertical piping, provide No. 22 U.S.G. galvanized iron, unless otherwise specified.
- C. Where conduits pass through the roof provide pre-molded synthetic rubber flashing boots or other approved means approved by the Roofing Contractor. Install as per Roofing Contractor.
- D. Provide any sleeve or opening not installed or made during construction under the requirements for cutting and patching.
- E. Provide sleeves as required in existing walls for renovation projects.

1.29 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4" larger, in both directions, than supporting unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3.
- B. Provide minimum 4" high bases for all floor mounted equipment unless noted otherwise.

1.30 ACCESS PANELS

- A. Provide panels with fire ratings equal to the surface in which they are installed and be 12" x 12" or 4" larger than each dimension of the enclosed box, whichever is greater.

1.31 EXAMINATION OF CONTRACT DOCUMENTS

- A. Carefully examine the architectural, civil, structural, electrical, plumbing and sprinkler drawings. If any discrepancies occur between the drawings or between the drawings and the specifications, report such discrepancies to the Engineer and the Architect in writing in a Request For Information (RFI) form and obtain written instructions as to the manner in which to proceed. Make no departures from the contract drawings without prior written approval of the Architect/Engineer.
- B. Report any discrepancies prior to the submission of bid. In the event such discrepancies are not reported and claims for extra charges to the contract result, such claims will be allocated to and paid for by the Contractor, who, in the opinion of the Engineer and the Architect, is the responsible party.

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1.32 INSTRUCTION OF EMPLOYEES

- A. At the completion of the work this Contractor shall instruct the employees who shall have charge of the equipment in the care, adjustment, and operation of all parts of the system.
- B. At the time designated by the Architect, the equipment manufacturer's engineer shall instruct representatives of the Owner in the operation and maintenance of the equipment.

1.33 GENERAL NOTE

- A. The HVAC Contractor shall replace filters in all new air handling equipment once for system balancing and once again at the completion of the project. Any permanent equipment used for conditioning of the building during construction shall have temporary filters installed, replaced on a weekly basis, to keep interior of equipment and ductwork clean and free of construction dust and dirt. Filters shall be MERV 10
- B. Provide functional testing for all HVAC equipment. Contractor shall complete and submit Mechanical Equipment Checkout sheet for each HVAC Unit. (See attached). Functional testing shall be completed by the HVAC Contractor together with his ATC Sub-Contractor in the presence of the Owner and Engineer.
- C. Attention is directed to Article 23 "Exclusion of Certain Aluminum, Steel and Cast-Iron Products" in the General Conditions of the Construction Contract for references to statutes that impose restrictions for this project on the use of foreign-made steel and steel products.
- D. All mechanical equipment shall bear the label of an approved agency.
- E. All mechanical equipment shall be installed in accordance with the manufacturers' installation instructions which shall be available at job site.
- F. Contractor shall provide the following attic stock to the Owner at completion of the project:
 - 1. Contractor shall provide a complete filter change for each piece of equipment upon occupancy of area by Owner.
 - 2. Additionally, furnish one set of filters. A chart shall be provided indicating filter sizes and related HVAC equipment.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment to permit removal of components and parts which require periodic replacement or maintenance. Arrange pipes, ducts, and equipment to permit access to valves, gauges, starters, motors, doors and access panels.
- B. Provide access panels in equipment, ducts, etc. as required for inspection and maintenance.

3.2 PIPING INSTALLATION

- A. In general, piping shall be exposed in equipment rooms, and concealed in all finished rooms. Where piping is exposed, it shall be run so as to allow maximum headroom consistent with proper pitch. No piping or ductwork shall cross below the head of any window or door.
- B. Exposed piping, ducts, conduits, and/or appurtenances indicated on the inside of buildings, shall be installed parallel to the building lines. All piping shall be kept as close as possible to the ceilings and walls, and columns, to take up the minimum amount of space.

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- C. All work shall be arranged and installed as high as possible to prevent obstruction of window areas, and to give adequate clearance and access for operation and maintenance.

3.3 SLEEVES

- A. Where pipes pass through concrete or masonry walls or concrete floors, they shall be protected through the full depth of the construction with galvanized sleeves; same to be at least one size larger than the pipe plus insulation.
- B. Where sleeves occur in concrete floors, the top of sleeve shall be flush with finished floor line, and the end shall be filed to a smooth round finish.
- C. This Contractor shall supply all pipe sleeves and shall inform general contractor of exact sleeve locations in time for their incorporation onto the concrete forms or masonry work.
- D. Any cutting and patching in masonry or concrete made necessary by failure to adequately coordinate with the general contractor shall be done by the Masonry or Pre-Cast Contractor at the expense of this contractor.
- E. The space between pipes and sleeves shall be caulked airtight with a non-combustible inorganic material.

3.4 UNIONS

- A. Unions shall be provided at all connections to each piece of equipment and on both sides of all automatic valves, and devices which requires removal for maintenance. No unions are to be placed in a location which will be inaccessible after the completion of the project.
- B. Unions of copper tubing shall be 200 lbs. SWP brass ground joint.
- C. Unions for steel pipe shall be 250 lbs. SWP, malleable iron with brass to iron seat.

3.5 CLEARANCE

- A. All piping, including valves and fittings shall be installed to provide the following minimum clearances between the finish coverings, adjacent pipe and/or conduits: 2" between for piping services and 6" between piping services and electrical conduits.

3.6 ESCUTCHEON PLATES

- A. All piping passing through walls, ceilings, and floors shall be provided with escutcheon plates securely fastened in place. Where installed on piping in finished areas they shall be chrome plated.

3.7 ACCESS PANELS

- A. Removable panels shall be located to provide easy access to all concealed plumbing accessories that may require adjustments or maintenance, such as valves, water hammer arresters, traps, strainers, cleanouts or others.
- B. Access panels in finished wall or ceiling surfaces shall be furnished by this Contractor for installation by the General Contractor.
- C. This Contractor shall pay for any work made necessary by his failure to inform other trades of access panel locations.

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3.8 APPLICATIONS OF INSULATION AND COVERING

- A. No covering shall be installed by the Contractor until the piping and ducts have been approved by the Architect/ Engineer.

3.9 PIPING UNDER FLOORS

- A. Wherever piping, conduits and associated materials is run under a floor slab on grade, the work is to be installed after the sub-grade has been brought to the proper level. The work shall then be installed and backfilled, allowed to settle, and refilled before placing crushed stone fill.

3.10 INSERTS

- A. Except as noted, provide box type inserts for all hangers and supports intended to suspend piping or lightweight equipment from new concrete construction. Fasten all inserts to the formwork before concrete is poured. Inserts to be Grinnel Figure No. 282 or Figure No. 279 depending upon the maximum load to be carried.
- B. No toggle bolts, expansion screw anchors or similar imbedded hanger supports shall be used in new construction.

3.11 CHASES AND OPENINGS IN FLOORS AND WALLS

- A. It shall be the duty of the Contractor requiring chases, openings or the placement of any sleeves, anchors, and supports required for his work, whether or not shown on the drawings, to advise the General Contractor accordingly, prior to or at the time of pouring concrete slabs, beams or the building of walls, etc. He shall furnish all such sleeves, anchors, and supports in place, and all necessary information for the proper location of said chases or openings.
- B. If a contractor shall fail to observe and comply with those requirements, he shall cut, at his own expense, after receiving the consent of the Architect, such chases or openings as may be necessary and proper, providing and building in place all lintels required by these openings, doing the necessary patching and rebuilding of the work required under the direction of the General Contractor and he shall be responsible for all loss or delay resulting therefrom.

3.12 LUBRICATION

- A. The contractor shall provide all oil for the operation of all equipment until acceptance. The Contractor shall run in all bearings and, after they are run in, drain all oil from the bearings, flush out all bearings, and refill with new oil. The Contractor shall be held responsible for all damage to bearings while equipment is being operated by him up to the date of acceptance of the equipment. The contractor shall be required to protect all bearings during installation and shall thoroughly grease steel shafts to prevent corrosion. All motors and other equipment shall be provided with covers as required for proper protection during construction.

3.13 JOINTS AND CONNECTIONS

- A. Screwed Connections - All joints made in screwed pipe shall be made with red lead or pipe compound applied to the threaded end of the pipe and not applied within the fitting. Threads shall be cut straight and true with sections reamed and cleaned before installation.

3.14 CEILING TILE REMOVAL

- A. The Contractor shall remove and replace ceiling tile and grid work as required for the installation of mechanical work. Damaged tile and grid shall be replaced by the Contractor and shall match the existing ceiling system.

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3.15 EQUIPMENT CHECKOUT SHEET

- A. See sheet attached.

END OF SECTION 23 00 10

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MECHANICAL EQUIPMENT CHECKOUT SHEET

UNIT/ROOM # _____ DATE: _____
 RTU ☐ AH ☐ 100% Make-Up Supply Unit ☐ O.A. TEMP: _____
 Energy Recovery RTU ☐

SPACE TEMP	FAN STARTS	YES	☐	NO	☐
	O.A. DAMPER CLOSED	YES	☐	NO	☐
	FAN STARTS	YES	☐	NO	☐
WARMUP	R.A. DAMPER OPEN	YES	☐	NO	☐
	RELIEF DAMPER CLOSED	YES	☐	NO	☐
	HEAT VALVE MODULATES OPEN	YES	☐	NO	☐
OCCUPIED HEAT	O.A. DAMPER TO MIN. POSITION	YES	☐	NO	☐
	R.A. AND RELIEF MOD. PRO-PORTIONAL TO O.A. DAMPER	YES	☐	NO	☐
OCCUPIED COOL H/W VALVE	MOD. CLOSED	YES	☐	NO	☐
	O.A. DAMPER MOD. OPEN	YES	☐	NO	☐
	R.A. & RLF MOD. PROP. TO O.A.	YES	☐	NO	☐
UNOCCUPIED	FAN STOPS	YES	☐	NO	☐
	O.A. DAMPER CLOSED	YES	☐	NO	☐
	R.A. DAMPER OPEN	YES	☐	NO	☐
FAN CYCLE & H/W VALVE	MOD OPEN TO MAINTAIN SETBACK TEMP	YES	☐	NO	☐
		YES	☐	NO	☐
FREEZE CONTROL	FAN STOPS	YES	☐	NO	☐
	O.A. DAMPER CLOSES	YES	☐	NO	☐
	HEAT VALVE OPEN	YES	☐	NO	☐
FIRE/SMOKE CONTROL	FAN STOPS	YES	☐	NO	☐
	O.A. DAMPER CLOSES	YES	☐	NO	☐

DISCHARGE AIR TEMP HEATING _____ COOLING _____

RETURN AIR TEMP HEATING _____ COOLING _____

NOTES:

TECHNICIAN _____ OWNER REP. _____ DATE _____

FILTER ACCESS YES ☐ NO ☐ COMMENT
 MAINTENANCE ACCESS YES ☐ NO ☐ COMMENT

SECTION 23 01 00 - MECHANICAL GENERAL EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pressure Gauges and Pressure Gauge Taps
- B. Thermometers and Thermometer Wells
- C. Pipe and Equipment Hangers and Supports
- D. Equipment Bases and Supports
- E. Sleeves and Seals
- F. Flashing and Sealing Equipment and Pipe Stacks
- G. Single Phase Electric Motors
- H. Three Phase Electric Motors
- I. Nameplates
- J. Tags
- K. Stencils
- L. Pipe Markers
- M. Vibration Isolation

1.2 REFERENCES

- A. ASME - B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element
- B. ASTM E1 - Specification for ASTM Thermometers
- C. ASTM E77 - Verification and Calibration of Liquid-in-Glass Thermometers
- D. UL 393 - Indicating Pressure Gauges for Fire and Protection Services
- E. ASTM F708 - Design and Installation of Rigid Pipe Hangers
- F. MSS SP58 - Pipe Hangers and Supports - Materials, Design, and Manufacturer
- G. MSS SP69 - Pipe Hangers and Supports - Selection and Application
- H. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices
- I. NFPA 13 - Installation of Sprinkler Systems
- J. NFPA 14 - Installation of Standpipe and Hose Systems

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- K. NEMA MG 1 - Motors and Generators
- L. NFPA 70 - National Electrical Code
- M. ASME A13.1 - Scheme for the Identification of Piping Systems

1.3 SUBMITTALS

- A. Provide in accordance with provisions of Section 23 00 10.
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
 - 3. Gauges and Meters: Provide list which indicates use, operating range, total range, and location for manufactured components.
 - 4. Supports and Anchors: Provide manufacturers catalog data including load capacity.
 - 5. Motors: Provide wiring diagrams with electrical characteristics and connection requirements.
 - 6. Mechanical Identification: Provide manufacturers catalog literature for each product required.
 - 7. Vibration Isolation: Provide schedule of vibration isolator type with location and load on each.
- C. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

1.4 REGULATION REQUIREMENTS

- A. Conform to applicable electrical code.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

- A. Manufacturer: Moeller
- B. Other acceptable manufacturers offering equivalent products.
 - 1. American
 - 2. Terice
 - 3. Weksler
 - 4. Substitutions: Permitted in accordance with Division 1.
- C. Gauge: ASME B40.1, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2"
 - 3. Mid-Scale Accuracy: 1%
 - 4. Scale: Both psi and kPa

2.2 PRESSURE GAUGE TAPPINGS

- A. Needle Valve: Brass 1/4" NPT for minimum 150 psig.
- B. Pulsation Damper: Pressure snubber, brass with 1/4" connections.

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2.3 STEM TYPE THERMOMETERS

- A. Manufacturer: Moeller
- B. Other acceptable manufacturers offering equivalent products.
 - 1. American
 - 2. Terice
 - 3. Weksler
 - 4. Substitutions: Permitted in accordance with Division 1
- C. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
 - 1. Size: 9" scale.
 - 2. Window: Clear glass.
 - 3. Stem: 3/4" NPT brass.
 - 4. Accuracy: ASTM E77 2%
 - 5. Calibration: Both °F and °C

2.4 DIAL THERMOMETERS

- A. Manufacturer: Moeller
- B. Other acceptable manufacturers offering equivalent products.
 - 1. American
 - 2. Terice
 - 3. Weksler
 - 4. Substitutions: Permitted in accordance with Division 1
- C. Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 - 1. Size: 3-1/2" diameter dial
 - 2. Lens: Clear glass
 - 3. Accuracy: 1%
 - 4. Calibration: Both °F and °C

2.5 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3" outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.6 TEST PLUGS

- A. Test Plug: 1/4" or 1/2" brass fitting and cap for receiving 1/8" outside diameter pressure or temperature probe with Nordel core for temperatures up to 350°F.
- B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2" diameter pressure gauges, one gauge adapters with 1/8" probes, two 1" dial thermometers.

2.7 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 - 1. Grinnell
 - 2. Other acceptable manufacturers offering equivalent products.
 - a. or approved equal

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- B. HVAC Piping:
1. Conform to ASTM F708, MSS SP58, MSS SP69, MSS SP89.
 2. Hangers for Pipe Sizes 1/2 to 12": Malleable iron adjustable swivel, split ring.
 3. Hangers for Cold Pipe Sizes 2" and Over: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes 2 to 4": Carbon steel, adjustable, clevis.
 5. Hangers for Hot Pipe Sizes 6" and Over: Adjustable steel yoke, cast iron roll, double hanger.
 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6" and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
 8. Wall Support for Pipe Sizes to 3": Cast iron hook.
 9. Wall Support for Pipe Sizes 4" and Over: Welded steel bracket and wrought steel clamp.
 10. Wall Support for Hot Pipe Sizes 6" and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast-iron roll.
 11. Vertical Support: Steel riser clamp.
 12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 13. Floor Support for Hot Pipe Sizes to 4": Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 14. Floor Support for Hot Pipe Sizes 6" and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
 15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.8 PIPE HANGER ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.9 INSERTS

- A. Manufacturers:
1. Grinnell
 2. Other acceptable manufacturers offering equivalent products.
 - a. or approved equal
- B. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.10 FLASHING

- A. Metal Flashing: 26-ga galvanized steel.
- B. Metal Counterflashing: 22-ga galvanized steel.
- C. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- D. Caps: Steel, 22-ga minimum; 16-ga at fire resistant elements.

2.11 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18-ga galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18-ga galvanized steel.
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Sleeves for Rectangular Ductwork: Galvanized steel.

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- E. Firestopping Insulation: Glass fiber type, non-combustible.
- F. Sealant: Acrylic

2.12 MOTORS

- A. Manufacturers:
 - 1. Century
 - 2. Westinghouse
 - 3. Lincoln
 - 4. Baldor
 - 5. Or approved equal
- B. General Construction and Requirements:
 - 1. Motors Less Than 250 Watts, for Intermittent Service: Equipment manufacturer's standard and need not conform to these specifications.
 - 2. Electrical Service:
 - a. Refer to Section 260180 for required electrical characteristics.
 - 3. Type:
 - a. Open drip-proof except where specifically noted otherwise.
 - b. Motors: Design for continuous operation in 40°C environment.
 - c. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - d. Motors with frame sizes 254T and larger: Energy Efficient Type.
 - 4. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.
 - 5. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
 - 6. Wiring Terminations:
 - a. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - b. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.
 - 7. Provide thermal overload protection for all motors per NEC.

2.13 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 12"-diameter.
- B. Chart: Typewritten letter size list in anodized aluminum frame. Room numbers shall correspond to Owners room numbering system.

2.14 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4 to 1-1/4" Outside Diameter of Insulation or Pipe: 8" long color field, 1/2" high letters.
 - 2. 1-1/2" to 2" Outside Diameter of Insulation or Pipe: 8" long color field, 3/4" high letters.
 - 3. 2-1/2" to 6" Outside Diameter of Insulation or Pipe: 12" long color field, 1-1/4" high letters.
 - 4. 8 to 10" Outside Diameter of Insulation or Pipe: 24" long color field, 2-1/2" high letters.
 - 5. Over 10" Outside Diameter of Insulation or Pipe: 32" long color field, 3-1/2" high letters.
 - 6. Ductwork and Equipment: 2-1/2" high letters.
- B. Stencil Paint: As specified in Section 099123, semi- gloss enamel, colors conforming to ASME A13.1.

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2.15 PIPE MARKERS

- A. Color: Conform to ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6" wide by 4 mil thick, manufactured for direct burial service.

2.16 VIBRATION ISOLATORS

- A. Neoprene Pad Isolators:
 - 1. Rubber or neoprene waffle pads
 - a. 30 durometer
 - b. Minimum 1/2" thick
 - c. Maximum loading 40 psi
 - d. Height of ribs shall not exceed 0.7 times width
 - 2. Configuration: Single layer
- B. Rubber Mount or Hanger: Molded rubber designed for 0.5" deflection with threaded insert.
- C. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

2.17 ROOF EQUIPMENT SUPPORTS

- A. Provide roof equipment support as manufactured by Pate Co. Style ES or accepted substitute.
- B. Equipment support shall be constructed of galvanized steel with continuous welded seams for stiffness and moisture protection. Support shall be built-in raised cant, wood nailer and be 12" high minimum.

2.18 ROOF PIPE PORTAL ASSEMBLY

- A. Provide roof pipe curb assembly as manufactured by Pate Co. Style PCA or accepted substitute.
- B. Pipe curb assembly shall be constructed of insulated galvanized steel curb with 2" wood nailer, plastic cover, and graduated neoprene boots with stainless steel clamps.
- C. Provide pipe curb assembly for piping that penetrates roof membrane.

2.19 FIRESTOPPING

- A. Acceptable Manufacturer:
 - 1. EGS Nelson Firestop Product
 - 2. 3M
 - 3. Approved Equal
- B. Products:
 - 1. Nelson ES1399 Elastomeric Sealant: Water based acrylic latex, endothermic fire protective sealant. It is used for applications of through firestop penetrations and in construction joints. It is available in two grades, N/S (Non-Sag) for wall and overhead installations, and S/L (Self-Leveling) for floor installations.
 - 2. Nelson WRS+ Firestop Wrap Strips: to be used as a wrap around PVC type pipes. After the pipe is covered with the correct number of wraps the WRS+ is covered with a field cut and fabricated collar cover is used in conjunction with CLK or FSP which provide a smoke seal.

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3. Nelson PCS Pipe Choke System Collars: To be used on PVC type pipes and conduits to produce an immediate smoke and fire seal. Each PCS is pre-filled with a highly intumescent pliable putty material. Collars are furnished in exact sizes from 1.5" to 4". Collars are UL System Classified for through penetrations of drywall or concrete/masonry assemblies.
4. Nelson LBS+ Firestop Latex Based Sealant: A one part "Latex-Water Based" Intumescent caulk that is of a non-sag formulation for use in all applications, wall, floor and overhead.

2.20 STARTERS

- A. All starters shall be Hand/Off/Auto Type.
- B. Starters for rooftop equipment (ERU's, EF's, etc.) shall be mounted at the unit on the roof and shall be NEMA rated, weatherproof for exterior installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Gauges and Meters:
 1. Install positive displacement meters with isolating valves on inlet and outlet. Provide full line size valved bypass with globe valve for liquid service meters.
 2. Install pressure gauges with pulsation dampers. Provide needle valve to isolate each gauge. Extend nipples to allow clearance from insulation.
 3. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
 4. Install thermometers in air duct systems on flanges.
 5. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
 6. Locate duct mounted thermometers minimum 10' downstream of mixing dampers, coils, or other devices causing air turbulence.
 7. Coil and conceal excess capillary on remote element instruments.
 8. Provide instruments with scale ranges selected according to service with largest appropriate scale.
 9. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45° off vertical.
 10. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
 11. Locate test plugs adjacent thermometers and thermometer sockets, pressure gauges, and pressure gauge taps and where indicated.
- B. Mechanical Identification:
 1. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
 2. Install tags with corrosion resistant chain.
 3. Apply stencil painting in accordance with Section 099123.
 4. Install plastic pipe markers in accordance with manufacturer's instructions.
 5. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
 6. Install underground plastic pipe markers 6 to 8" below finished grade, directly above buried pipe.
 7. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with stencil painting. Small devices, such as in-line pumps, may be identified with tags.
 8. Identify control panels and major control components outside panels with plastic nameplates.
 9. Identify thermostats relating to terminal boxes or valves with nameplates.
 10. Identify valves in main and branch piping with tags.
 11. Identify air terminal units and radiator valves with numbered tags.
 12. Tag automatic controls, instruments, and relays. Key to control schematic.
 13. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4" diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20' on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

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14. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
 15. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
 16. Provide Valve Identification Chart. Post framed chart in Boiler Room.
- C. Vibration:
1. Install isolation for motor driven equipment.
 2. Bases:
 - a. Set steel bases for 1" clearance between housekeeping pad and base.
 - b. Set concrete inertia bases for 2" clearance between housekeeping pad and base.
 - c. Adjust equipment level.
 3. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
 4. Connect wiring to isolated equipment with flexible hanging loop.
 5. All vibration isolation devices, including steel bases and pouring forms, shall be supplied by a single manufacturer.
 6. All piping located in Boiler Room, shall be isolated from the building structure by means of spring hangers.
 7. For Air Handlers not located in the Mechanical Rooms, all piping 1" in diameter or greater shall be isolated with spring hangers having the same deflection, for the first three hangers, as those for the machine to which it is connected.
 8. Bases for all end suction pumps shall be sized to include supports for the suction and discharge elbows.
 9. Flexible conduit shall be used for all electrical connections to isolated equipment. Flexible conduit shall be 50% longer than the actual distance between the rigid conduit and the equipment electrical connection locations.
 10. The schedule of isolators required shall be as follows: Roof Top Units – 2" static deflection Spring isolators, Chiller - 1" deflection isolators; Pumps - inertia bases, 1" (minimum) deflection springs; Air handling units in mechanical rooms on grade - 1/2" deflection neoprene or fiberglass pads; Fan coil units and FPV terminals - 1" deflection springs; piping - all piping in the mechanical rooms should have isolation hangers having the same deflection as those for the equipment in the rooms, or for 50' from the equipment, whichever is greater. For the ceiling mounted air handling units, any piping larger than 1" diameter should have the first three hangers of the same deflection as the equipment (1"). Provide spring hangers for piping in Boiler Room.
 11. Spring hangers for piping shall consist of clevis type hangers with spring hanger similar to Grinnell Fig. 247 or Fig. B-268 installed in threaded rod.
 12. All ductwork connections to equipment shall be flexible connections.
- D. Motors:
1. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
 2. Check line voltage and phase and ensure agreement with nameplate.
- E. Inserts:
1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4".
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- F. Pipe Hangers and Supports:
1. Support horizontal piping as scheduled.
 2. Install hangers to provide minimum 1/2" space between finished covering and adjacent work.
 3. Place hangers within 12" of each horizontal elbow.
 4. Use hangers with 1-1/2" minimum vertical adjustment.
 5. Support horizontal cast iron pipe adjacent to each hub, with 5' maximum spacing between hangers.
 6. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

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7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Support riser piping independently of connected horizontal piping.
9. Provide copper plated hangers and supports for copper piping.
10. Design hangers for pipe movement without disengagement of supported pipe.
11. Provide additional supports for heavy valves and specialties and provide sway bracing where needed.
12. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
13. Insulation protection saddles shall be installed at all pipe hangers and supports for insulated lines. Saddles shall be rolled with a radius to suit the insulation O.D. Saddles shall be #16-ga galvanized steel and shall be 8" long.

G. Equipment Bases and Supports:

1. Provide housekeeping pads of concrete, minimum 4" thick and extending 4" beyond supported equipment except pads in Boiler Room shall be 12" deep.
2. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
3. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
4. Provide rigid anchors for pipes after vibration isolation components are installed.

H. Flashing:

1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
2. Flash vent and soil pipes projecting 3" minimum above finished roof surface with lead worked 1" minimum into hub, 8" minimum clear on sides with 24" x 24" sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.
3. Flash floor drains in floors with topping over finished areas with lead, 10" clear on sides with minimum 36" x 36" sheet size. Fasten flashing to drain clamp device.
4. Seal floor, shower and mop sink drains watertight to adjacent materials.
5. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.
6. Provide curbs for mechanical roof installations 12" minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
7. Adjust storm collars tight to pipe with bolts, caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

I. Sleeves:

1. Set sleeves in position in formwork. Provide reinforcing around sleeves.
2. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
3. Extend sleeves through floors 1" above finished floor level. Caulk sleeves.
4. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
5. Install chrome plated steel escutcheons at finished surfaces.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Section 230010.

3.3 SCHEDULES

A. Supports and Hangers

HANGER ROD PIPE SIZE	MAX. HANGER SPACING	DIAMETER
<u>Inches</u>	<u>Feet</u>	<u>Inches</u>
Up to 1	6	3/8
1-1/4 to 2	9	3/8
2-1/2 to 3	10	1/2
4 to 5	12	5/8

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6	12	3/4
8 to 12	12	7/8
14 and Over	12	1
PVC (All Sizes)	4	3/8
C.I. Bell and Spigot (or No-Hub) and at Joints	5	3/4

3.4 APPLICATION

A. Motors:

1. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.
2. Single phase motors for fans, pumps, blowers, air compressors: Capacitor start type.
3. Motors located in exterior locations: Totally enclosed type.
4. Motors located in outdoors: Totally enclosed weatherproof epoxy-treated type.
5. Motors located in outdoors: Totally enclosed weatherproof epoxy-sealed type.
6. All Motors - All motors shall be high efficiency type.

END OF SECTION 23 01 00

SECTION 23 02 50 - INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping Insulation
- B. Jackets and Accessories
- C. Equipment Insulation
- D. Covering
- E. Ductwork Insulation
- F. Duct Liner

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)
- B. National Fire Protection Association (NFPA)
- C. Underwriters Laboratories (UL)
- D. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
- E. ASHRAE Standard 90A-1980

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 23 00 10.
- B. Product Data: Provide product description, list of materials and thickness for each service, and locations.

1.4 QUALITY ASSURANCE

- A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, UL 723.

PART 2 - PRODUCTS

2.1 PIPING

- A. Manufacturers
 - 1. Owens-Corning
 - 2. Johns Manville
 - 3. Certainteed
 - 4. Armstrong
 - 5. PPG
 - 6. Knauf

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2.2 DUCT INSULATION

- A. Provide and install acoustic and thermal lining in all supply air, treated ventilation air, transfer air, and return air ductwork as specified. Exhaust only ductwork (including fume hood exhaust) does not need insulated unless specifically noted.
- B. Lining shall be fiberglass semi-rigid board type, or duct liner, 2.0 PCF density, with a thermal conductivity of approximately 0.16 BTU/Hr – sq ft - °F – inch and a minimum R-value of 6.3 or greater.
- C. All insulation shall meet the code required flame and smoke ratings and shall be suitable for plenums.
- D. All outside air and make-up air duct work systems shall be 2-inch thick, 1.5-lb/cu.ft. nominal density mineral fiber blanket.

2.3 HVAC PIPING AND EQUIPMENT INSULATION

- A. All hot water supply and return pipes, fittings, suction diffusers, hot surfaces, flanges, and valves shall be insulated with heavy density fiberglass insulation, similar to Owens/Corning Fiberglass 25ASJ/SSL pipe insulation or accepted substitute, with all service jacket, self-sealing lap and U.L. listed.
- B. All exterior HVAC water piping shall be insulated with 2" fiberglass insulation. Insulation shall be covered in an aluminum jacket with sealed joints for a weatherproof insulation. Install with heat tape for freeze protection.
- C. Pipe and equipment insulation shall meet or exceed the IECC conductivity and thickness requirements. Piping and equipment insulation thickness shall be as listed in section 3.2.M of this specification.

2.4 REFRIGERANT PIPING

- A. All refrigeration lines shall be insulated in accordance with IECC Table C403.2.10 above with flexible elastomeric closed cell pipe insulation, Armaflex FR/Armaflex or approved equal having flame spread rating of 25 or less when tested by ASTM-84 method.
- B. All exposed FR/Armaflex insulation shall be finished with two coats of Armstrong Armaflex Finish or accepted substitute. Color to be selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping, equipment, materials, have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. On exposed piping, locate insulation and cover seams in least visible locations.
- C. Insulated pipes and equipment conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory applied, or field applied.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
 - 3. PVC fitting covers shall be used.
 - 4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

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5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- D. For insulated pipes and equipment conveying fluids above ambient temperature:
 1. Provide standard jackets, with vapor barrier, factory applied, or field applied.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
 3. PVC fitting covers shall be used.
- E. For exterior piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Heat tracing to be by E.C.
- F. Cover hydrous calcium silicate insulation or Fiberglass Industrial Insulation Board with metal mesh and finish with heavy coat of insulating cement.
- G. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
- H. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.
- I. Insulation including finishes and adhesive on the exterior surfaces of ducts and equipment shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less as determined by an independent testing laboratory in accordance with ASTM E84, NFPA 255-1972 as required by NFPA 90A. Smoke development rating for pipe insulation shall not exceed 50. Duct coverings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411.
- J. Linings in air ducts and equipment shall meet the Erosion Test Method described in Underwriter's Laboratories Publication No. 181. These linings, including coatings and adhesives and insulation on exterior surfaces of pipes and ducts in building spaces used as air supply plenums, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less as determined by an independent testing laboratory in accordance with NFPA 255-1972, ASTM E84 as required by NFPA 90A. Linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411.
- K. HVAC Piping shall be insulated with thickness of insulation indicated below: (In accordance with ASHRAE 90A-1980)
 1. Hot Water Supply, Return

<u>Pipe Size</u>	<u>Thickness</u>
Up to 1-1/4"	1-1/2"
1-1/2" and Up	2"
- L. Duct Insulation:
 1. All insulation surfaces shall be coated with a compound to prevent erosion, flaking, or peeling of liner material at air velocities of 3000 ft./minute.
 2. Insulation shall be applied using UL approved fire-retardant adhesive and mechanical fasteners. Adhesive shall be water-based Foster 85-17 or approved equal. Mechanical fasteners shall be Gripnail Corporation, or equal with self-locking washers, and shall be spaced not more than 6 inches apart on leading edges of liner.
 3. Top sheets of insulation in rectangular ducts shall lap the side sheets.
 4. All joints and seams in the lining shall be painted to a smooth surface with a fire-retardant insulation sealer, Foster 30-70 or equal as approved.
 5. Duct liner shall be anti-microbial.
 6. Liner shall be impervious to dust and dirt.
- M. Refrigerant Pipe Insulation: Insulate per manufacturers recommendation.

END OF SECTION 23 02 50

SECTION 23 05 10 - HVAC PIPING & SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings for:
 - 1. Heating Water Piping System
 - 2. Refrigerant Piping
- B. Valves:
 - 1. Gate Valves
 - 2. Ball Valves
 - 3. Butterfly Valves
 - 4. Check Valves
- C. Air Vents
- D. Air Separator
- E. Specialties
- F. Expansion Tanks

1.2 REFERENCES

- A. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators
- B. ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- E. ASME B31.9 - Building Services Piping
- F. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
- G. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
- H. ASTM B32 - Solder Metal
- I. ASTM B88 - Seamless Copper Water Tube
- J. ASTM F708 - Design and Installation of Rigid Pipe Hangers
- K. AWS A5.8 - Brazing Filler Metal
- L. AWS D1.1 - Structural Welding Code
- M. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture
- N. MSS SP69 - Pipe Hangers and Supports - Selection and Application

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- O. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices

1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Use grooved mechanical couplings and fasteners in accessible locations.
- C. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment, or other apparatus.
- D. Use non-conducting dielectric connections whenever jointing dissimilar metals.
- E. Provide pipe hangers and supports in accordance with ASTM B31.9 unless indicated otherwise.
- F. Use gate, ball, or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- G. Use ball or butterfly valves for throttling, bypass, or manual flow control services.
- H. Use 3/4" ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

1.4 SUBMITTALS

- A. Submit in accordance with provisions of Section 23 00 10.
- B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Welders Certificate: Include welders' certification of compliance with ASME SEC 9.

1.5 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.

PART 2 - PRODUCTS

2.1 HEATING WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53, Schedule 40, black.
 - 1. Fittings: ASTM B16.3, malleable iron, or ASTM A234, forged steel welding type fittings.
 - 2. Joints: Threaded, (up to 2") or AWS D1.1, welded (over 2" size).
 - 3. For piping 2-1/2" and larger, a coupling system will be acceptable for couplings, tees, reducers, elbows, valves, and strainers as specified herein. Provide proper gaskets for reducers, elbows, valves, and strainers as specified herein. Provide proper gaskets for system working temperature and pressure. Acceptable manufacturers shall be Victaulic (Basis of Design) or Gruvlok.
 - a. Victaulic standard fittings will be ASTM A536 ductile iron, ASME A234 forged steel, or ASTM A53 fabricated steel, with factory grooved ends designed to accept Victaulic standard couplings.
 - b. Victaulic standard couplings consist of two ASTM A536 ductile iron housing segments, a pressure-responsive synthetic rubber gasket, grade "E" EPDM for water services to 230°F, secured together with plated steel bolts and nuts.

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- 1) Rigid Type: Housings will be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9. Victaulic Style 07 Zero-Flex.
 - 2) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings shall be placed in close proximity to the source of vibration. Victaulic Style 75 or 77.
 - c. Victaulic flange adapters will be cast ductile iron, ASTM A536, flat faced, for incorporating flanged components with ANSI Class 125, 150 or 300 bolt-hole patterns to a grooved piping system. Victaulic Style 741 or 743.
- B. Copper Tubing: ASTM B88, Type L, hard drawn.
 1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535°F.
 3. For piping 2" and larger, a coupling system will be acceptable for couplings, tees, reducers, elbows, valves, and strainers as specified herein. Provide proper gaskets for reducers, elbows, valves, and strainers as specified herein.
 - a. Couplings for Copper Grooved Tube:
 - 1) Mechanical Couplings: 2" to 8" (DN50-DN200) for copper tubing consisting of ductile iron cast housings, complete with a synthetic rubber gasket of a pressure-responsive design, with plated nuts and bolts to secure unit together. Couplings shall be manufactured to connect copper tubing sized tube and fittings. (Flaring of tube and fitting ends to IPS dimensions is not allowed.)
 - a) Coupling Housings: Ductile iron conforming to ASTM A-536, Grade 65-45-12, coated with copper colored alkyd enamel. Housings cast with offsetting, angle-pattern bolt pads to provide rigidity.
 - b) Coupling Gaskets: Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30°F to +250°F. reference shall always be made to the latest published Victaulic Selection Guide for Gaskets for proper gasket selection for the intended service.
 - c) Victaulic Style 607 (Quick-Vic): Installation ready rigid coupling for direct stab installation without field disassembly.
 - 2) Flange Adapters for Copper Tubing: 2" - 6" (DN50-DN150) for copper tubing consisting of ASTM A-536, Grade 65-45-12, ductile iron housing, coated with copper colored alkyd enamel. Flange adapters shall be manufactured for engaging directly into copper tubing sized roll grooved copper tube and fittings and bolting directly to ANSI Class 125 cast iron and Class 150 steel flanged components. Victaulic Style 641.
 - b. Grooved-End Copper Fittings: Fittings shall be manufactured to copper tubing sizes, with grooves designed to accept grooved end couplings of the same manufacturer. Fittings shall be wrought copper, conforming to ASTM B-75 alloy C12200 or ASTM B-152 alloy C11000 and ANSI B16.22, or bronze sand-casting ANSI B16.18 and UNS-C89836. Victaulic Copper Connection Fittings.
 - c. Grooved-End Copper Valves:
 - d. Butterfly Valves: 2-1/2" - 6" (DN65-DN150), 300 psi (2065 kPa) maximum pressure rating, with copper tubing sized grooved ends. Cast bronze body to UNS C87850. Aluminum-bronze cast disc conforming to UNS C95500. Bubble tight, dead-end, or bi-directional service, with memory stop for throttling, metering, or balancing service. Disc shall be offset from the stem centerline to allow full 360° seating. Seat shall be pressure responsive Grade "CHP" Fluoroelastomer. Valve may be automated with electric, pneumatic, or hydraulic operators. Victaulic Series 608N

2.2 REFRIGERANT PIPING

- A. Copper Tubing: ASTM B280, Type ACR hard drawn.
 1. Fitting: ASME B16.22 wrought copper.
 2. Joints: Braze, AWS A5.8 BcuP silver/phosphorous copper alloy with melting range 1190° to 1480°F.
- B. Valves and associated specialties shall be suitable for refrigerant service.

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2.3 PIPE HANGERS AND SUPPORTS

- A. Conform to ASME B31.9, ASTM F708, MSS SP89.

2.4 GATE VALVES

- A. Over 3":
1. Manufacturers:
 - a. Nibco
 - b. Crane
 - c. Stockham
 2. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends.
 3. Ductile iron body and closure access bonnet, stainless steel clapper with synthetic rubber bonded bumper and synthetic rubber clapper seat, horizontal swing, grooved ends. Victaulic Series 712.

2.5 BALL VALVES

- A. Up to and Including 3":
1. Manufacturers:
 - a. Nibco
 - b. Crane
 - c. Stockham
 2. Bronze 2-piece body, bronze ball, Teflon seats and stuffing box ring, lever handle with balancing stops, solder, or threaded ends.
 3. For chilled water valves, use NIB-seal insulated handle ball valves by Nibco or accepted substitute.
 4. Ductile iron body and closure access bonnet, stainless steel clapper with synthetic rubber bonded bumper and synthetic rubber clapper seat, horizontal swing, grooved ends. Victaulic Series 712.

2.6 BUTTERFLY VALVES

- A. Manufacturers:
1. Victaulic
 2. Jamesbury
 3. Crane
 4. Anvil – Gruvlok Company
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.
- C. Disc: Aluminum bronze.
- D. Operator: 10 position lever-handle with memory stop or Handwheel and gear drive.
- E. Grooved End Butterfly Valves:
1. 2" thru 12": Ductile iron body, electroless nickel-plated ductile iron, aluminum bronze, or stainless-steel disc 416 stainless steel stem. Disc shall be offset from the stem centerline to provide continuous 360° seating, EPDM seat and seal material, TFE lined fiberglass bearings, 10 position lever handle or gear operator with handwheel with memory stop. Valve shall be suitable for bubble tight shutoff, bi-directional and dead-end service at 300 psi full rated pressure. Victaulic Series 712.
 2. EPDM seals, 17-4 PH stainless steel stem, reinforced PTFE bearings, gear operator with handwheel and memory stop, AGS grooves. Valves shall be suitable for bubble tight shutoff, bi-directional and dead-end service. Victaulic Series 712.

2.7 SWING CHECK VALVES

- A. Manufacturers:

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1. Nibco
 2. Crane
 3. Stockham
 4. Victaulic
 5. Anvil – Gruvlok Company
- B. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder, or threaded ends.
- C. Ductile iron body and closure access bonnet, stainless steel clapper with synthetic rubber bonded bumper and synthetic rubber clapper seat, horizontal swing, grooved ends. Victaulic Series 712.
- 2.8 HYDRONIC EXPANSION TANKS
- A. Manufacturers:
1. Amtrol Horizontal AX Series ASME
 2. Taco
 3. John Wood
- B. Construction: Welded steel, tested and stamped in accordance with ASME SEC VIII, Division 1 standards; supplied with National Board Form U-1, rated for working pressure of 125 psig, with replaceable, full acceptance 0.1 minimum thickness bladder design, Schrader Air Valve with EPDM seals.
- C. Accessories: Pressure gauge and air-charging fitting, tank drain, pre-charge to 12 psig.
- 2.9 CENTRIFUGAL TYPE AIR SEPARATOR
- A. Manufacturers:
1. Basis of Design: Bell and Gossett Rolairtrol
 2. Acceptable Substitute Manufacturers:
 - a. Amtrol
 - b. Armstrong
 - c. TACO
- B. Construction: The unit shall have flanged connections of the size of the entering pipe, tangential to the vessel shell. The unit shall have an internal type 304 stainless steel strainer and air separator. Air shall be directed to an NPT connection on the top of the unit. Unit shall be designed and constructed and stamped for 125 psig @ 350°F in accordance with Section VII, Division I of the ASME Boiler and Pressure Vessel Code. Provide unit with blowdown connection with necessary accessories for manual blowdown.
- 2.10 TRIPLE DUTY VALVES
- A. Manufacturers:
1. Bell & Gossett
 2. Taco
 3. Armstrong
 4. Amtrol
 5. Victaulic Company
 6. Anvil – Gruvlok Company
- B. Valves: Straight or angle pattern, flanged cast iron valve body with bolt-on bonnet for 175 psig operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.
- C. Tri-Service Valve Assembly: Combination shut-off, throttling, and non-slam check service in one unit. Victaulic Vic-300 MasterSeal butterfly valve assembled with Series 779 Venturi Check with flow measurement capabilities and grooved joint couplings (style to be determined by system requirements) and memory stops, 300 psi CWP rating, grooved ends.

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2.11 AIR VENTS

- A. Manufacturers:
 - 1. Taco
 - 2. Bell & Gossett
 - 3. Armstrong
 - 4. Amtrol
- B. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure with isolating valve.

2.12 STRAINERS

- A. Manufacturers:
 - 1. Sarco
 - 2. ITT Hoffman
 - 3. Bell & Gossett
 - 4. Victaulic
 - 5. Anvil – Gruvlok Company
- B. Threaded or flanged, screwed brass or iron body for 175 psig working pressure, Y pattern with stainless steel perforated screen.
- C. Grooved End Strainers:
 - 1. Y Pattern, 2" thru 12": Straight thru flow, ductile iron body, Type 304 stainless steel perforated metal removable basket with 0.062" or 0.125" diameter perforations, blowdown port with pipe plug, grooved ends, 300 psi CWP. Victaulic Style 732.
 - 2. T Pattern, 2" thru 12": Straight thru flow, ductile iron body, Type 304 stainless steel frame and mesh removable basket with #12 mesh with 0.063" opening or #6 mesh with 0.126" opening, removable access coupling and end cap for strainer maintenance, grooved ends, up to 750 psi CWP. Victaulic Series 730.
 - 3. T Pattern, 14" thru 24": Straight thru flow, carbon steel body, Type 305 stainless steel frame and mesh removable basket with #6 mesh with 0.126" opening or #4 mesh with 0.203" opening, carbon steel T-bolt hinged closure for strainer maintenance, AGS grooved ends, 300 psi per CWP. Victaulic Series W730.

2.13 FLOW CONTROLS

- A. Manufacturers:
 - 1. Bell & Gossett Circuit Setter Plus
 - 2. Taco
 - 3. Armstrong CBU
- B. Bronze body, brass ball construction with TFE seat rings. Provide with differential pressure readout ports, memory stop, calibrated nameplate, and preformed insulation. Furnish with threaded connections.

2.14 RELIEF VALVES

- A. Manufacturers:
 - 1. Watts
 - 2. Bell & Gossett
 - 3. Taco
- B. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled, sized for specific application.

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2.15 BACKFLOW PREVENTER

- A. Backflow preventer shall be Watts Regulator Series LF909HW for temperatures up to 210°F (99°C) or equal.
- B. The assembly shall consist of a pressure differential relief valve located in a zone between two positive seating check valves. Backsiphonage protection shall include provision to admit air directly into the reduced pressure zone via a separate channel from the water discharge channel, or directly into the supply pipe via a separate vent. The assembly shall be constructed using Lead Free* cast copper silicon materials. The Lead Free* reduced pressure zone assembly shall comply with state codes and standards, where applicable, requiring reduced lead content. The assembly shall include two tightly closing shutoff valves before and after the assembly, test cocks and a protective strainer upstream of the No. 1 shutoff valve. The assembly shall meet the requirements of ASSE Std. 1013.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install heating water, chilled water piping to ASME B31.9.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls, and floors.
- G. Slope piping and arrange to drain at low points.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 01 00.
- I. Pipe Hangers and Supports:
 - 1. Install in accordance with ASTM B31.9, ASTM F708 and MSS SP89.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 2" space between finished covering and adjacent work.
 - 4. Place hangers within 12" of each horizontal elbow.
 - 5. Use hangers with 12" minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

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- 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- K. Provide access where valves and fittings are not exposed.
- L. Slope piping and arrange systems to drain at low points.
- M. Install valves with stems upright or horizontal, not inverted.
- N. Hydronic piping shall be tested with water at 150 psig and system shall not lose over 2 psig in two hours with no visible signs of leakage.
- O. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- P. Provide clearance for installation of insulation and access to valves and fittings.
- Q. Install unions downstream of valves and at equipment or apparatus connections.
- R. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- S. Install ball valves for throttling, bypass, or manual flow control services.
- T. Provide flow controls in water recirculating systems where indicated. Size valves to meet flow quantities indicated.
- U. Provide traps at condensate pipe connection to all units.
- V. Refrigerant piping shall be sized and installed per applicable codes and equipment manufacturer's recommendations.
 - 1. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping and provide double risers as required. Slope horizontal piping to 0.40% in direction of flow.
 - 2. Flood piping system with nitrogen when brazing.
 - 3. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
 - 4. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
 - 5. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
 - 6. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
 - 7. Provide liquid line dryer.
 - 8. Provide liquid line sight-glass.
 - 9. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
 - 10. Fully charge completed system with refrigerant after testing.
 - 11. Test refrigeration system in accordance with ASTM B31.5.

END OF SECTION 23 05 10

SECTION 23 05 40 - HVAC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Inline Pumps
- B. Variable Frequency Pump Drives

1.2 REFERENCES

- A. UL 778 - Motor Operated Water Pumps
- B. NFPA 70 - National Electrical Code

1.3 PERFORMANCE REQUIREMENTS

- A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.

1.4 SUBMITTALS

- A. Submit in accordance with provisions of Section 23 00 10.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Include dimensions, weights.

1.5 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.6 EXTRA MATERIALS

- A. Provide one set of mechanical seals for each pump.

PART 2 - PRODUCTS

2.1 INLINE CIRCULATOR PUMP

- A. Manufacturers:
 - 1. Bell & Gossett Model 80 – Basis of Design
 - 2. Approved substitutes:
 - a. Aurora
 - b. Armstrong
 - c. Penn Pump Co.
- B. The pumps shall be of a horizontal, permanently lubricated, specifically designed, and guaranteed for quiet operation. Suitable for 225°F operation at 175 psig working pressure. The pump shall be single stage, vertical split case design, in cast bronze fitted construction. The pump internals shall be capable of being serviced without disturbing piping connections.

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- C. The pumps shall be composed of 3 separable components: a motor, bearing assembly, and pump end (wet end). The motor shaft shall be connected to the pump shaft via a replaceable flexible coupler.
- D. The pumps shall have a solid SAE 1144 steel shaft supported by 2 ball bearings. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.
- E. Pump shall be equipped with an internally flushed mechanical seal assembly. Seal assembly shall have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
- F. Bearing assembly shaft shall connect to a cast bronze impeller. Impeller shall be both hydraulically and dynamically balanced, keyed to the shaft and secured by a locking cap screw or nut.
- G. A flexible type coupling to dampen starting torque and torsional vibration shall be employed between the pump and motor.
- H. Pump shall be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
- I. Pump volute shall be of cast iron design for heating systems. The connection style on cast iron and bronze pumps shall be flanged. Volute shall include gauge ports at nozzles and vent and drain ports.
- J. To ensure alignment the motor shall be mounted to the bearing assembly via a bolted motor bracket assembly, and a rubber mount will be used to assist in aligning the motor shaft with the pump shaft.
- K. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors through 1 HP shall be resilient mounted, motors over 1.5 HP shall be rigid mounted. Motors shall have permanently lubricated ball bearings and must be maintenance free. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
- L. Each pump shall be factory tested and name-plated before shipment.
- M. Pump shall be provided with motor starter/disconnect for each pump. Motors for pumps with VFD shall be inverter rated suitable for use with VFD.

2.2 ADJUSTABLE FREQUENCY DRIVE

- A. The Adjustable Frequency Drive (AFD) shall be a sine coded pulse width modulated (PWM) design that operates directly from 3-phase 460 VAC +10% 60 Hertz utility power. The AFD shall generate a sine-coded, adjustable voltage/frequency 3-phase output for complete speed control of any conventional squirrel cage induction motor. The AFD shall maintain a 150% current overload capability for 20 seconds and automatic stall prevention and voltage boost to prevent nuisance tripping during load or line side transient conditions. The AFD shall maintain a power factor of not less than .95 throughout its speed range. The AFD shall communicate by serial link to the control system. No discrete wiring shall be required. All control of the AFD shall be over a single serial cable.
- B. The Adjustable Frequency Drive shall be Yaskawa, Softronics, Cutler Hammer, General Electric, Siemens.
- C. The Adjustable Frequency drive shall have the following basic design:
 - 1. Converter: Shall consist of a modularized diode rectifier and capacity assembly which will first convert, then filter and maintain a fixed DC voltage source from the fixed voltage and frequency input.
 - 2. Inverter: Shall use power transistor semi-conductors with a minimum rating 1100 VAC on 460 VAC controls and 550 volts on 230 VAC controls to invert the converter generator fixed DC voltage into a sine-coded pulse width modulated output.
 - 3. Control Logic: Shall consist of 2 printed circuit boards and incorporate a dual microcomputer central processing unit to control all inverter, converter, and external interface functions.
 - 4. Enclosure: Shall be NEMA 12 with external heatsink configuration to minimize panel heat loading.
 - 5. Design Features: The Adjustable Frequency Drive shall have as a minimum the following design features:

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- a. Sine-coded, pulse width modulated output
 - b. Dual microcomputer control logic
 - c. Controlled speed range of 40:1
 - d. Overload capability of 150% for 20 seconds
 - e. Process follower 4-20 mA or 0-10 VDC
 - f. 15 selectable Volts/Hertz patterns with energy-saver circuit
 - g. Coast or ramp to stop
 - h. Adjustable acceleration and deceleration
 - i. Run and fault LED's
 - j. Run and fault contacts for customer use
 - k. Bypass
6. Protective Features: The Adjustable Frequency Drive shall have, as a minimum, the following protective features:
- a. Ground-fault protection
 - b. Electronic thermal motor overload
 - c. Current limited stall prevention during acceleration, deceleration and run conditions
 - d. Automatic restart after momentary power loss
 - e. Start into a rotating motor with speed search
 - f. 10 function LED diagnostic circuit shall indicate the following fault conditions:
 - 1) Fuse loss
 - 2) Overcurrent
 - 3) Overload
 - 4) Overvoltage
 - 5) Momentary power loss under voltage
 - 6) Under voltage
 - 7) Heat sink over temperature
 - 8) External fault
 - 9) Control function error
 - 10) Control function selection error
 - a) DC bus discharge indicator
 - b) Current limiting DC bus fuse
 - c) Isolated operators' controls
 - d) Phase to phase short circuit protection
 - e) Heat sink over temperature protection
 - f) Motor KW
 - g) Motor current
 - h) DC bus voltage
7. Adjustments: The Adjustable Frequency Drive shall have the following adjustments available:
- a. Acceleration – 0.2 to 100 seconds linear
 - b. Deceleration – 0.2 to 1800 seconds linear
 - c. Volts/Hertz – 15 patterns
- D. The control center shall be UL listed including the variable frequency drive compartments. The control center shall also include an incoming line section with a main disconnect switch with door interlocking mechanism. The control center shall include a bottom (top) cable chase.
- E. The system controls shall accommodate the following remote signals: Drive running signal, flow, drive failed signal, common system alarm (digital), individual zone pressures, selected zone pressure (analog) and selected zone (digital), individual zone transmitter failed signal. All analog signals shall be 4-10 mADC and digital signals shall be dry form-C contacts. All analog signals must be isolated. All the above shall be able to be monitored from the building automation system.
- F. Provide VFD with two contactor bypass. The system logic shall provide automatic/manual control of across-the-line VFD bypass contactors which are to be provided as part of the variable frequency drive.
- G. Each drive and motor starter shall include a safety disconnect switch.

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PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4" and over.
- D. Provide drains for bases and seals, piped to and discharging into floor drains.
- E. Check, align, and certify alignment of base mounted pumps prior to start-up.
- F. Lubricate pumps before start-up.

END OF SECTION 23 05 40

SECTION 23 05 45 - CHEMICAL WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleaning of Piping Systems
- B. Chemical Feeder Equipment
- C. Chemical Treatment
- D. By-Pass Shot Feeder

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 23 00 10.
- B. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics, and connection requirements.
- C. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

1.4 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for to public sewage systems.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.5 MAINTENANCE SERVICE

- A. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.
- B. Provide quarterly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Industrial Hydro Solutions – No Substitutions (610) 207-5462

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2.2 BY-PASS (POT) FEEDER

- A. For hot water systems the Contractor shall install 5.0 gal shot feeder with funnel and air release valve for working pressure of 175 psig.

2.3 WATER TREATMENT CHEMICALS – HOT WATER BOILER SYSTEMS

- A. Furnish one year's supply of the recommended manufacturer's formula for scale and corrosion protection of closed recirculating system. Formulation shall not contain any ingredients which are harmful to system materials of construction or any heavy metals which may cause effluent discharge problems.

2.4 TESTING EQUIPMENT

- A. Furnish basic water test equipment, including carrying case and spare reagents for maintaining control of program standards in the hot water condenser and chilled water systems. Test kits will include the following:
 - 1. Reagents and apparatus for determination of corrosion inhibitor level in the hot water condenser and chilled water systems.
 - 2. Reagents and apparatus for determination of pH, P&M alkalinity, and chlorides.
 - 3. Apparatus for determination of microbiological colony population and biocide effectiveness.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.2 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping.

3.3 PREOPERATIONAL SYSTEM CLEANOUT

- A. All chilled water and hot water lines and related equipment shall be thoroughly flushed out with manufacturer's pre-cleaning chemicals designed to remove deposition such as pipe dope, oils, loose rust, mill scale and other extraneous materials. Recommended dosages of State pre-cleaner chemical products shall be added and circulated throughout the water system. The water system shall then be drained, refilled, and flushed thoroughly until no foreign matter is observed and the total alkalinity of the rinse water is equal to that of the make-up water.

3.4 WATER TREATMENT PROGRAM

- A. The Water Treatment Company shall provide:
 - 1. Installation and system start-up procedure recommendations
 - 2. Pre-operation system cleanout procedure supervision
 - 3. Initial water analysis and recommendations
 - 4. Training of operating personnel on proper feeding and control techniques
 - 5. Periodic field service and consultation meetings
 - 6. Any necessary log sheets and record forms
 - 7. Any required laboratory and technical assistance
- B. All services shall be provided by a qualified, full-time representative of the Water Treatment Company.

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3.5 PIPING AND WIRING

- A. Provide all necessary wiring and piping as required and as shown on drawings.

END OF SECTION 23 05 45

SECTION 23 05 70 - BOILERS & BURNERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wall Mounted High Efficiency Fire Tube Condensing Boilers
- B. Controls and Boiler Trim
- C. Flues (Direct Vent)

1.2 REFERENCES

- A. AGA Z21.13 - Gas-Fired Low-Pressure Steam and Hot Water Boilers
- B. ASME SEC 4 - Boiler and Pressure Vessel Codes - Rules for Construction of Heating Boilers
- C. ASME SEC 8D - Boiler and Pressure Vessel Codes - Rules for Construction of Pressure Vessels
- D. ASME CSD-1 (Controls and Safety Devices)
- E. HI (Hydronics Institute) - Testing and Rating Standard for Cast Iron and Steel Heating Boilers
- F. NFPA 54 (AGA Z223.1) - National Fuel Gas Code
- G. NFPA 70 - National Electrical Code
- H. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil-Fired Boilers – Minimum Efficiency Requirements".
- I. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers".
- J. UL Compliance: Boilers must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment". Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- K. NOx Emission Standards: When installed and operated in accordance with manufacturer's instructions, the following condensing boiler models shall comply with the NOx emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rule 1146.1; and the Texas Commission on Environmental Quality (TCEQ), Title 30, Chapter 117, and Rule 117.465 or the NOx emissions referenced "BMK6000: 9 ppm NOX corrected to 3% oxygen at all firing rates when firing on natural gas".

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 23 00 10.
- B. Product Data: Provide data indicating dimension, ratings, capacity, weight, general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
 - 1. Prior to flue vent installation, engineered calculations and drawings must be submitted to Architect/Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length, and footprint for each submitted boiler.

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1.4 QUALITY ASSURANCE

- A. The equipment shall, at a minimum, be in strict compliance with the requirements of this specification, shall perform as specified and shall be the manufacturer's standard commercial product unless specified otherwise.
- B. Electrically operated components specified are to be "Listed" and/or "Labeled" as defined by NFPA 70, Article 100.
- C. Boiler shall bear an ASME "H" stamp in accordance with ASME Section IV.
- D. Boiler shall be CSA certified to the ANSI Z21.13 / CSA 4.9 standard for Gas Fired Low Pressure Steam and Hot Water Boilers and shall bear an authorized CSA rating label.
- E. Boiler shall be AHRI listed and certified in accordance with the Commercial Boiler program and the BTS-2000 testing standard.
- F. Boiler shall undergo a Full Function Factory Fire Test and bear a fire test label.
- G. Boiler shall be registered through the National Board from the factory.
- H. The manufacturer shall make available, upon request, all quality assurance documentation and results of Full Function Factory Fire Test based on the boiler's serial number.

1.5 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70 code for internal wiring of factory wired equipment.
- B. Conform to ASME SEC 4 and SEC 8D and AGA Z21.13 for construction of boilers.
- C. ASME CSD-1 for boiler safety requirements.
- D. Units: AGA certified.
- E. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc.

1.6 COORDINATION

- A. Equipment shall be handled, stored, and installed in accordance with the manufacturer's instructions.
- B. Factory Authorized Start-up must be completed after all appliance connections are completed, e.g. gas piping, hydronic piping, exhaust venting & electrical

1.7 WARRANTY

- A. Warranty Period for Fire-Tube Condensing Boilers.
 - 1. The pressure vessel/heat exchanger shall carry a 10-year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects, or workmanship.
 - 2. All other components, with the exception of the igniter, flame detector and O_2 sensor, are conditionally guaranteed against any failure for (5) five years from shipment.

1.8 CERTIFICATION

- A. Manufacturer's Certification - The boiler manufacturer shall certify the following:
 - 1. The products and systems furnished are in strict compliance with the specifications.

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2. The boiler, burner and other associated mechanical and electrical equipment have all been properly coordinated and integrated to provide a complete and operable boiler.
 3. The boiler shall be in compliance with ANSI Z21.13 / CSA 4.9 (latest edition).
 4. The boiler shall be CSA certified for at least 96% efficiency based on operating conditions specified for testing under ANSI Z21.13 / CSA 4.9.
 5. The boiler shall be AHRI certified for at least 96% efficiency based on operating conditions specified for testing under BTS-2000.
 6. The boiler shall be in compliance with ASME Section IV (latest edition).
 7. The boiler shall be in compliance with ASME CSD-1 (latest edition).
 8. The boiler's H-3 form shall be registered with the National Board.
- B. Contractor's Certification - The installing contractor shall certify the following:
1. The products and systems installed are in strict compliance with the specifications and all applicable local and/or state codes.
 2. The specified field tests have been satisfactorily performed by a factory authorized startup agent.
 3. The equipment furnished contains inter-changeable parts with the specified equipment so that all major equipment parts can be obtained from the specified manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
1. Lochinvar Knight Model WHB
 2. The Boiler shall be a Lochinvar Knight Model WHB having a modulating input of 10:1 and shall be operated on Natural Gas. The boiler shall be capable of the performance indicated on the drawings.

2.2 CONSTRUCTION

- A. The Boiler shall bear the ASME "H" stamp for 80 psi working pressure and shall be National Board listed. The Boiler shall have a fully welded, stainless steel, fire tube heat exchanger. There shall be no banding material, bolts, gaskets or "O" rings in the pressure vessel construction. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. The condensate collection basin shall be constructed of welded stainless steel. The complete heat exchanger assembly shall carry a fifteen (15) year limited warranty.
- B. The Boiler shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard. The Boiler shall operate at a minimum of 94.4% THERMAL Efficiency as registered with AHRI. The Boiler shall be certified for indoor installation.
- C. The Boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided for observing the burner flame and combustion chamber. The burner shall be a premix design constructed of high temperature stainless steel with a woven Fecralloy outer covering to provide smooth operation at all modulating firing rates. The Boiler shall be supplied with a negative pressure regulation gas valve and be equipped with a pulse width modulation blower system to precisely control the fuel/air mixture to the burner. The Boiler shall operate in a safe condition with gas supply pressures as low as 4 inches of water column. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.

2.3 BOILER CONTROLS (as supplied with the basis of design boiler, alternate manufacturers shall provide equivalent boiler controls with all features indicated herewithin)

- A. The Boiler shall utilize a 24 VAC control circuit and components. The control system shall have a factory installed display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The Boiler shall be equipped with a temperature/pressure

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gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 30 psi (standard); outlet water temperature sensor with a dual thermistor to verify accuracy; system supply water temperature sensor; outdoor air sensor, flue temperature sensor with dual thermistor to verify accuracy; low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.

- B. The Boiler shall feature the "SMART SYSTEM™" control which is standard and factory installed with 128 x 128 resolution display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay featuring six steps, domestic hot water prioritization with limiting capabilities, USB drive for simple uploading of parameters and a PC port connection for connection to a local computer for programming and trending. A secondary operating control that is field mounted outside or inside the appliance is not acceptable. The Boiler shall have alarm contacts for any failure, runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures. The Boiler shall have a built-in "Cascade" with leader redundancy to sequence and rotate while maintaining modulation of up to the number of boilers provided of different Btu inputs without utilization of an external controller. The internal "Cascade" function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead boiler every 24 hours. The Boiler shall be capable of remote communication via optional CON-X-US™ Remote Connectivity with the capability of historical trending and sending text message or email alerts to notify the caretaker of a boiler alarm and remote programming of onboard boiler control. The control must have optional capability to communicate via Modbus protocol with a minimum of 46 readable points. The Boiler shall have an optional gateway device which will allow integration with BacNet protocols of the supplied ATC system.
- C. The "SMART SYSTEM™" control shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation. A 0-10 VDC output signal shall control a variable speed boiler pump (pump shall be supplied by manufacturer) to keep a fixed Delta T across the boiler regardless of the modulation rate. The Boiler shall have the capability to receive a 0-10 VDC input signal from a variable speed system pump to anticipate changes in system heat load in order to prevent flow related issues such as erratic temperature cycling.
- D. The Boiler shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 46 connection points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Low Water Cut Off, Louver Proving Switch, Tank Thermostat, Domestic Hot Water Building Recirculation Pump Contacts, Domestic Hot Water Building Recirculation Temperature Sensor Contacts, Remote Enable/Disable, System Supply Temperature Sensor, Outdoor Temperature Sensor, Tank Temperature Sensor, Modbus Building Management System Signal and Cascade Control Circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120 volt / 60 hertz / single phase on all models. The high voltage terminal strip plus integral relays are provided for independent pump control of the Secondary System pump and the Boiler pump.

2.4 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.

2.5 VENTING

- A. The Boiler shall be installed and vented with a Direct Vent system with horizontal sidewall termination of both the exhaust vent and combustion air. The flue shall be Category IV approved material constructed of CPVC, Polypropylene or Stainless Steel. A separate pipe shall supply combustion air directly to the boiler from the outside. The boiler's total combined air intake length shall not exceed 100 equivalent feet. The boiler's total combined exhaust venting length shall not exceed 100 equivalent feet
- B. Boiler shall come standard with a flue sensor to monitor and display flue gas temperature on factory provided LCD display.
- C. Refer to manufacturer's Installation and Operations manual for detailed venting instructions and approved manufacturers.

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2.6 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency. Perform hydrostatic testing.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
 - 1. If boilers are not factory assembled and fire-tested, the local vendor is responsible for all field assembly and testing.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect fourteen days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations and piping and electrical connections to verify actual locations, sizes and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54.
- C. Provide connection of natural gas service in accordance with NFPA 54 (AGA Z223.1)
- D. For wall mounted boilers provide any additional support hardware that is not provided with the boiler as necessary to mount the boilers on the wall indicated.
- E. Provide piping connections and accessories as indicated.
- F. Provide flue connections and accessories as indicated.
- G. Pipe relief valves to nearest floor drain.
- H. Provide for connection to electrical service.
- I. Provide Factory Start-up and Commissioning for Boilers.

3.3 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 boiler to permit service and maintenance.

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- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve.
- D. Connect gas piping to boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Connect hot water piping to supply and return boiler tapplings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves to nearest floor drain.
- G. Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect venting full size to boiler connections.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Perform hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests: The boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the boiler manufacturer to complete the following performance tests:
 - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 - 3. Perform field performance tests to determine capacity and efficiency of boilers.
 - 4. Repeat tests until results comply with requirements indicated.
 - 5. Provide analysis equipment required to determine performance.
 - 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
 - 7. Notify Architect in advance of test dates.
 - 8. Document test results in a report and submit to Architect.

END OF SECTION 23 05 70

SECTION 23 08 00 - HVAC SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Related Sections:
 - 1. Section 01 91 00 - Commissioning Requirements

1.2 DESCRIPTION

- A. The HVAC systems to be commissioned are as follows:

HVAC Systems

- Building Automation System
- Ductless AC Units
- Condensing Boilers
- Circulating pumps
- VRF Heat Pump System
- Energy Recovery Ventilators
- Exhaust Fans

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The HVAC Contractor shall provide all standard testing equipment required to perform startup, initial checkout, and testing requirements of Division 23.
- B. The Controls Contractor shall provide all standard testing equipment required to test the Building Automation and Automatic Temperature Control System (BAS), including calibration of valve and damper actuators and all sensors. Trend logs for functional testing shall be generated through the BAS interface, as requested by the CA. Otherwise, the CA will collect test data with data loggers.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the following tolerances. Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of ±0.1°F. Pressure sensors shall have an accuracy of ±2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 RESPONSIBILITIES

- A. HVAC, Controls and TAB Contractors: The commissioning responsibilities applicable to each of the HVAC, Controls and TAB Contractors of Division 23 are as follows:
 - 1. Construction and Acceptance Phases:
 - a. Attend the initial commissioning meeting conducted at the start of construction, the commissioning meeting held 30 days prior to startup of the primary equipment, and all commissioning team meetings.

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- b. Provide one copy of approved shop drawings, sequence of operations and startup reports for all commissioned equipment to the CA. Supplement the shop drawing data with the manufacturer's installation and start-up procedures. This material should be identical to the literature which will be included in the Operation and Maintenance Manuals.
 - c. The Operation and Maintenance Manuals shall be submitted to the CA prior to the start of training (3 weeks before start-up and training and at least 60 days before substantial completion).
 - d. During the startup and initial checkout process, execute all portions of the manufacturer's start-up checklists, for all commissioned HVAC equipment.
 - e. Perform and clearly document all completed startup, pre-functional checklists, and system operational checkout procedures, providing a copy to the CA.
 - f. The CA writes, coordinates, witnesses, and conducts functional performance test procedures. Contractors for each trade shall provide the necessary support to the CA to complete functional testing.
 - g. Address current A/E punch list items and Commissioning corrective action items before functional testing. Air TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air related systems.
 - h. Provide skilled technicians to execute starting of equipment and to perform tests in accordance with all Division 23 sections. Where specified, startup shall be performed by a factory authorized service representative. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
 - i. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA and A/E and retest the equipment.
 - j. Provide training of Owner's operating staff as specified in Division 23 Sections. Use expert qualified personnel.
 - k. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
 - 2. Warranty Period:
 - a. Correct deficiencies and make necessary adjustments to O&M manuals for applicable issues identified in any seasonal testing.
- B. HVAC Contractor: The responsibilities of the HVAC Contractor, during construction and acceptance phases in addition to those listed in (A) are:
- 1. Provide startup for all HVAC equipment.
 - 2. Calibrations: The HVAC CONTRACTOR is responsible to calibrate all factory installed sensors and actuators. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated by the HVAC CONTRACTOR.
 - 3. Supervise all commissioning activities executed by subcontractors, including the Controls Contractor.
 - 4. List and clearly identify on the as-built duct and piping drawings the locations of all fire dampers, duct detectors, temperature sensors, relative humidity sensors, static and differential pressure sensors (air and building pressure).
- C. Controls Contractor: The commissioning responsibilities of the Controls Contractor, during construction and acceptance phases in addition to those listed in (A) are:
- 1. Sequences of Operation Submittals. The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
 - a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components, and function.
 - b. Logic diagrams detailing the flow of information for each control algorithm. These diagrams should include all inputs, outputs, and computations.
 - c. All interactions and interlocks with other systems.
 - d. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
 - e. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included but will generally require additional narrative).
 - f. Start-up sequences.
 - g. Warm-up mode sequences.

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- h. Normal operating mode sequences.
 - i. Unoccupied mode sequences.
 - j. Shutdown sequences.
 - k. Capacity control sequences and equipment staging.
 - l. Temperature and pressure control: setbacks, setups, resets, etc.
 - m. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 - n. Effects of power or equipment failure with all standby component functions.
 - o. Sequences for all alarms and emergency shutdowns.
 - p. Seasonal operational differences and recommendations.
 - q. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
 - r. Schedules, if known.
 - s. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. Where possible, the numbering sequence shall correspond with Section 23 0900 "ATC Systems".
2. Control Drawings Submittal:
- a. The control drawings shall have a key to all abbreviations.
 - b. The control drawings shall contain graphic schematic depictions of the systems and each component.
 - c. The schematics shall include the system and component layout of any equipment that the control system monitors, enables, or controls, even if the equipment is primarily controlled by packaged or integral controls.
 - d. Provide a full points list with at least the following included for each point:
 - 1) Controlled system
 - 2) Point abbreviation
 - 3) Point description
 - 4) Display unit
 - 5) Control point or setpoint (Yes / No)
 - 6) Input point (Yes / No)
 - 7) Output point (Yes / No)
 - e. The Controls Contractor shall keep the A/E, CA, HVAC, and TAB Contractor informed of all changes to this list during programming and setup.
3. Submit a written checkout plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional testing. At minimum, the checkout plan shall include for each type of equipment controlled by the building automation system:
- a. System name.
 - b. List of devices.
 - c. Step-by-step procedures for testing each controller after installation, including:
 - 1) Process of verifying proper hardware and wiring installation.
 - 2) Process of downloading programs to local controllers and verifying that they are addressed correctly.
 - 3) Process for performing and documenting point-to-point checkout for each digital and analog input and output.
 - 4) Process of performing operational checks of each controlled component.
 - 5) Plan and process for calibrating valve and damper actuators and all sensors.
 - 6) A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
 - d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor, controller or command has "passed" and is operating within the contract parameters.
 - e. A description of the instrumentation required for testing.
 - f. Indicate the portion of the controls checkout plan that should be completed prior to TAB using the controls system for TAB work. Coordinate with the CA and TAB Contractor for this determination.
4. Point-to-Point Checkout: Include in the checkout plan a point-to-point checkout. Each control point tied to a central control system shall be verified to be commanding, reporting, and controlling according to its intended purpose. For each output, commands shall be initiated and verified to be functioning by visually observing and documenting the status of the controlled device in the field

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(e.g. valve or damper actuator response, pump, or fan status). For each input, the system or conditions shall be altered to initiate the input response being tested and the response in the control system observed and recorded (e.g. high duct static pressure alarm).

5. Calibrations: The CONTROLS CONTRACTOR is responsible to calibrate all field installed sensors and actuators using test and documentation methods approved by the CA. The HVAC CONTRACTOR is responsible to calibrate all factory installed sensors and actuators.
 - a. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated by the HVAC CONTRACTOR.
 - b. Valve leak-by tests shall be conducted by the Contractor when shown on a construction checklist.
 - c. All procedures used shall be fully documented by the Controls Contractor on suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate, and final results.
6. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as indicated in the Specifications.
7. Provide a signed and dated certification to the CA upon completion of the Building Automation and Automatic Temperature Control System (BAS) installation, including checkout and calibration of each controlled device, that all system programming is complete as to all respects of the Contract Documents. This shall be submitted by the Controls Contractor prior to the start of functional testing by the CA.

D. TAB Contractor: The scope of work for the TAB Contractor is provided in Section 230990.

3.2 SUBMITTALS

- A. The Contractor shall send one copy of product data, shop drawings and similar submittals to the CA at the same time they are submitted to the A/E. The CA will review the submittals and provide any comments to the A/E for inclusion in their comments. The Architect will transmit to the CA, for the CA's use in preparing functional test procedures; one reviewed and approved copy of product data, shop drawings and similar submittals received from the HVAC, Controls and TAB Contractors, pertinent to equipment and systems to be commissioned.

3.3 STARTUP

- A. The HVAC, Controls and TAB Contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section. Equipment start-up is required to complete systems and sub-systems so they are fully functional, in compliance with the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Agent or Owner.
- B. Testing is intended to begin upon completion of a system. Refer to Section 019100 for additional information related to scheduling.

3.4 TESTS

- A. The HVAC and Controls Contractors shall provide the necessary support to the CA to complete functional testing. The Controls Contractor shall fully test and verify all aspects of the BAS Contract Work on a point / system / integrated operational basis for all points, features and functions specified. The following requirements apply to all mechanical and control systems and features that are to be commissioned when referenced below. Tests shall:
 1. Verify functionality and compliance with the basis of design for each individual sequence module in the sequence of operations. Verify proper operation of all control strategies, energy efficiency and self-diagnostics features by stepping through each sequence and documenting equipment and system performance. Tests shall include startup, normal operation, shutdown, scheduled 'on' and 'off', unoccupied, and manual modes, safeties, alarms, over-rides, lockouts, and power failure.
 2. Verify operation of systems and components that may be impacted during low, normal, and high load conditions and during combinations of environmental and interacting equipment conditions that could reasonably exist and potentially result in adverse system reaction.

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3. Verify all alarm and high and low limit functions and messages generated on all points with alarm settings.
 4. Verify integrated performance of all components and control system components, including all interlocks and interactions with other equipment and systems.
 5. Verify shutdown and restart capabilities both for scheduled and unscheduled events (e.g. power failure recovery and normal scheduled start / stop).
 6. Verify proper sequencing of heat transfer elements as required to prevent simultaneous heating and cooling, unless specifically required for dehumidification operation.
 7. Verify system response and stability of control loops under different load conditions and determine if additional loop tuning is required by the Controls Contractor.
 8. When applicable, demonstrate a full cycle from 'off' to 'on' and 'no load' to 'full load' and then to 'no load' and 'off'.
 9. Verify time of day schedules and setpoints.
 10. Verify all energy saving control strategies.
 11. Verify that all control system graphics are representative of the systems and that all points and control elements are in the same location on the graphic as they are in the field.
 12. Verify operator control of all adjustable control system points including proper access level as agreed to during the controls system demonstration.
- B. In addition to specific details, and/or standards referenced for acceptance testing indicated in other Division 23 sections, the following common acceptance criteria apply to all mechanical equipment, assemblies, and features:
1. For the conditions, sequences and modes tested, the equipment, integral components and related equipment shall respond to varying loads and changing conditions and parameters appropriately as expected, according to the sequence of operation, as specified, according to acceptable operating practice and the manufacturer's performance specifications.
 2. Systems shall accomplish their intended function and performance (e.g. provide supply air and water at designated temperature and flow rate, etc., and maintain space conditions in terms of air temperature, relative humidity, and CO2 concentration) at specified levels at varying conditions.
 3. Control loops shall be stable under all operating conditions. Control loops shall exhibit a quarter decay ratio type responses to a step change or other upset and return to stable operation in a time frame that is reasonable and realistic for the system that they are associated with.
 4. All safety trips shall require a manual reset to allow a system restart, unless otherwise explicitly stated in the specified sequence of operation.
 5. Resetting a manual safety shall result in a stable, safe, and predictable return to normal operation by the system.
 6. Safety circuits and permissive control circuits shall function in all possible combinations of selector switch positions (hand, auto, inverter, bypass, etc.).
 7. Additional acceptance criteria will be defined by the CA when detailed tested procedures are developed.
- C. At the CA's discretion, if large numbers or repeated deficiencies are encountered, the CA shall suspend functional testing until the Contractor corrects the deficiencies and troubleshoots all remaining systems at issue on their own. The Contractor shall be responsible for any resulting schedule delays that increase the overall time period to complete functional testing.

3.5 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors will consist of the filled-out start-up, initial checkout, pre-functional checklists, and test documentation in accordance with all Division 23 sections.

END OF SECTION 23 08 00

SECTION 23 08 35 - HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hot Water Cabinet Heaters
- B. Hot Water Unit Heaters
- C. Finned Tube Radiation
- D. VRF Heat Pump Systems
- E. Ductless Split System Air Conditioner
- F. Electric Radiant Ceiling Panel

1.2 REFERENCES

- A. AMCA 99 – Standard Handbook
- B. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes
- C. AMCA 500 – Test Methods for Louvers, Dampers, and Shutters
- D. AMCA 611-95 – Methods of Testing Airflow Measurement Stations for Rating
- E. ANSI/AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings
- F. ANSI/UL 900 – Test Performance of Air Filter Units
- G. AHRI 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment
- H. AHRI 410 – Forced-Circulation Air Cooling and Air Heating Coils
- I. ANSI/AHRI 430 – Performance Rating of Central-Station Air Handling Units
- J. ASHRAE 52.1/52.2 – Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size
- K. ASHRAE 62 – Ventilation for Acceptable Indoor Air Quality
- L. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- M. ASTM-C 1338 – Standard Test Method for Determining Fungi Resistance of Insulation Material and Facings.
- N. NFPA 70 – National Electric Code (conductors, equipment and raceways)
- O. NFPA 90A – Installation of Air Conditioning and Ventilation Systems
- P. SMACNA – HVAC Duct Construction Standards

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- Q. UL-181 – Mold Growth and Humidity Test
- R. UL-1995 – Standard for Safety for Heating and Cooling Equipment

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with provisions of Section 23 00 10.

1.4 QUALITY ASSURANCE

- A. Manufacturer shall have a minimum of 25 years of experience in designing, manufacturing, and servicing air-handling units.
- B. The design indicated on the schedules and shown on the drawings is based upon the products of the named manufacturer. Alternate equipment manufacturers are acceptable if equipment meets scheduled performance requirements and dimensional requirements.
- C. VRF Systems:
 - 1. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
 - 2. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.

1.5 COORDINATION

- A. If equipment is supplied by a manufacturer other than the one listed as the Basis of Design, coordinate with the General Contractor and affected subcontractors to ensure the specified performance is met. This coordination shall include (but is not limited to) the following:
 - 1. Structural supports for units.
 - 2. Size and location of concrete bases/housekeeping pads.
 - 3. Location of roof curbs, unit supports and roof penetrations.
 - 4. Ductwork sizes and connection locations.
 - 5. Piping size and connection/header locations.
 - 6. Interference with existing or planned ductwork, piping and wiring.
 - 7. Electrical power requirements and wire/conduit and over current protection sizes.
 - 8. Trap height requirements.
- B. The Mechanical Contractor shall be responsible for costs incurred by the General Contractor, Subcontractors, and Consulting Engineers to accommodate units furnished by a manufacturer other than manufacturer named as basis of design.

1.6 RATINGS AND CERTIFICATIONS

- A. Unit shall conform to AMCA 210 for fan performance ratings.
- B. Unit shall conform to E.T.L. standards. Unit shall be ETL listed.
- C. Unit sound ratings shall be reported in accordance with AHRI 260 for inlet and discharge sound power levels.
- D. Unit casing radiated sound ratings shall be reported in accordance with ISO 9614 parts 1&2 and ANSI S12.12.
- E. Unit shall conform to AHRI 410 for capacities, pressure drops, and selection procedures of air coils.

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- F. Unit shall conform to ANSI/AHRI 430 for all fabrication procedures of air handling units.
- G. Motors covered by the Federal Energy Policy Act (EPACT) shall meet EPACT requirements.
- H. Damper performance shall comply with AMCA 500.
- I. Airflow Monitoring Stations shall be rated in accordance with AMCA 611-95 and bear a Certified Ratings Seal for Airflow Measurement Performance.
- J. Units shall be ISO 9001 certified.
- K. Units shall be manufactured in an ISO 9002 certified facility.
- L. Filter media to comply with ANSI/UL 900 listed Class I or Class II.
- M. Control Wiring comply with NEC codes & ETL requirements.
- N. Units shall comply with energy use AHSRAE 90.1.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Comply with ASHRAE 62, Section 5 (mold and corrosion resistant casings, filters upstream of wetted surfaces, and drain pan design).
- B. Comply with ASHRAE 62, Section 7 (practices to be followed during construction and startup). Protect equipment from moisture by appropriate in-transit and on-site procedures.
- C. Follow manufacturer's recommendations for handling, unloading and storage.
- D. Protect, pack, and secure loose-shipped items within the air-handling units. Include detailed packing list of loose-shipped items, including illustrations and instructions for application.
- E. Protect, pack and secure controls devices, motor control devices and other electronic equipment. Do not store electronic equipment in wet or damp areas even when they are sealed and secured.
- F. Enclose and protect control panels, electronic or pneumatic devices, and variable frequency drives. Do not store equipment in wet or damp areas even when they are sealed and secured.
- G. Seal openings to protect against damage during shipping, handling and storage.
- H. Wrap indoor units with a tight sealing membrane. Wrapping membrane shall cover entire AHU during shipping and storage. Cover equipment, regardless of size or shape. Alternatively, AHU must be tarped for shipment and storage.
- I. Wrap equipment, including electrical components, for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust and corrosion. Keep equipment clean and dry.
- J. Clearly mark AHU sections with unit tag number, segment sequence number, and direction of airflow. Securely affix safety-warning labels.

1.8 EXTRA MATERIALS

- A. Provide one set of filters for balancing, and one additional set for final turnover to owner.
- B. Provide one extra set of belts, in addition to the factory-installed set.

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1.9 WARRANTY

- A. Provide warranty for 18 months from date of shipment. Warranty shall cover manufacturer defects. Warranty work shall be performed by manufacturer's factory-trained and factory-employed technician.
- B. Include factory-provided controls in the parts warranties.
- C. Parts associated with routine maintenance, such as belts and air filters shall be excluded.
- D. VRF System:
 - 1. The Basis of Design Mitsubishi CITY MULTI units shall be covered by the manufacturer's limited warranty for a period of one (1) year parts and seven (7) year compressor to the original owner from date of installation.
 - 2. Installing contractor shall meet manufacturer requirements to obtain extended manufacturer's limited parts and compressor warranty for a period of ten (10) years to the original owner from date of installation. This warranty shall not include labor.
 - 3. Manufacturer shall have a minimum of fifteen (15) years continuous experience providing VRF systems in the U.S. market.
 - 4. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required.
 - 5. Registering and sign-in requirements which may delay emergency service reference are not allowed.
 - 6. The Mitsubishi CITY MULTI VRF system shall be installed by a contractor with previous CITY MULTI install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

1.10 SYSTEM START-UP

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.
- B. Comply with manufacturer's start-up requirements to ensure safe and correct operation and integrity of warranty.
- C. VRF System Start-up: System start-up supervision shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in system configuration and operation. The representative shall provide proof of manufacturer certification indicating successful completion within no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS - CONVECTORS, UNIT HEATERS, CABINET UNIT HEATERS

- A. Basis of Design shall be Modine
- B. Accepted Substitutes:
 - 1. American Air Filter
 - 2. Trane
 - 3. Slant Fin
 - 4. Sterling
 - 5. Sigma
 - 6. Rittling

2.2 CABINET HEATERS

- A. General: Furnish and install Cabinet Unit Heaters where indicated on the plans and in the

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specifications, with required mounting components and accessories. All units shall be capable of meeting or exceeding the scheduled capacities for heating and air delivery. Units shall be ETL certified for the United States and Canada in compliance with UL/ANSI Standard 1995 and CSA C22.2 No. 236-95.

- B. Construction: All unit chassis shall be fabricated of 20-ga galvanized steel panels. Insulation must meet all requirements of ASTM C1071 (including C665), UL 181 for erosion, and carry a 25/50 rating for flame spread/smoke developed per ASTM E-84, UL 723 and NFPA 90A.
 - 1. All exposed units shall have exterior front, top, and end panels fabricated of not less than 16-ga cold rolled steel (14-ga steel). The front panel shall be attached with tamper-proof Allen-head quarter turn fasteners to allow for easy removal and access for service. The front panel shall be hinged providing full swing through 90° including removable safety chain(s) to prevent the panel from swinging fully open accidentally (RC, RFRC, RRC). Side panels shall be removable for access to controls and piping within the end pockets, if required. End pockets shall be no less than 8" in width, located on both sides of the unit.
 - 2. All exposed units shall include a recessed stamped louver discharge grille. Louver discharge grille shall be reverse stamped, leaving a smooth exterior surface.
 - 3. Louvered panel shall be supplied with two flush, hinged access doors with tamper-proof Allen-head security quarter turn fasteners.
 - 4. Recessed units shall be provided with a wall/ceiling seal assembly. The assembly shall provide a finished appearance to the wall/ceiling.
- C. Painted Finish: All cabinet exterior panels shall be painted a custom color selected by the architect. Liquid coat paint shall not be acceptable.
- D. Power: Units shall not exceed scheduled power consumption.
- E. Fan and Motor: Unit fan shall be dynamically balanced, forward curved, DWDI centrifugal type constructed of galvanized steel for corrosion resistance. Motors shall be permanent split-capacitor (electronically commutated high-efficiency, programmable brushless DC), totally enclosed, tap wound for 3-speed, permanently lubricated sleeve bearing, type with automatic reset integral thermal overload protection. High static motors are available for ducted applications. Shaded pole motors are not acceptable. Single speed motors are not acceptable. Prior to shipping, all motors shall be assembled, factory tested and installed in the unit.
 - 1. The fan/motor assembly shall be removable and serviceable through the front panel. Each fan/motor assembly shall be fastened by no more than 4 screws. The motors shall have quick connects to allow service and removal without the need for tools.
- F. Coils:
 - 1. All heating coils shall optimize rows to meet the specified capacity. Coils shall have 5/8" OD, 1/2" nominal seamless copper tubes and shall be mechanically expanded to provide an efficient, permanent bond between the tube and aluminum fin. Minimum copper tube thickness shall be 0.016".
 - 2. Fins shall have high efficiency aluminum surface optimized for heat transfer, air pressure drop, and carryover. Minimum fin thickness shall be 0.0045". Lanced fins shall not be acceptable.
 - 3. All coils shall be tested at 350-psig air pressure under water, and rated for a maximum 300-psig working pressure at 200°F. Coils shall be circuited for counter flow to maximize unit efficiency.
 - 4. All water coils shall be designed to connect with 1/2" nominal pipe connections.
 - 5. All water coils shall be provided with a manual air vent fitting to allow for coil venting.
- G. Filters: All units shall be furnished with a minimum 1" pleated MERV 4 filter.
 - 1. Filters shall be tight fitting to prevent air bypass.
 - 2. Filters shall be easily removable from the return air opening without the need for tools, unless there is an inlet louvered return provided.
- H. Electrical: Units shall be furnished with single point power connection. Provide an electrical control board for motor and other electrical terminations using spade connectors. Provide 24 VAC fan relays with 40 VA transformer as integral part of control board. Fan relays designed to operate in conjunction with field provided 24 V thermostat. Fan relays designed to accept 120, 208, 220, 230, or 277 V input power. Relays shall operate with generic digital, programmable thermostat designed to control up to 3

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independently energized fan speeds.

1. Provide a service disconnect switch to isolate power from the unit during maintenance.
 2. Primary internal wiring and testing shall be conducted at the factory. All units shall be shipped with wiring diagrams.
- I. Piping Packages: Provide a standard factory assembled valve piping package to consist of a 2-way, on/off, motorized electric control valve and two ball isolation valves.
1. Control valves shall be piped normally open to the coil. Control valves shall be wired to junction box or unit mounted thermostat, when provided, through quick connects to allow service and replacement of valves. Maximum entering water temperature on the control valve shall be 200°F, and maximum operating pressure shall be 300-psig. Unions shall be provided to allow easy removal of piping package from unit without the need for brazing or cutting pipe.
 2. Provide pressure-temperature ports (P/T) for each piping package to allow measurement across the coil.
 3. Piping packages shall be completely factory assembled including interconnecting pipe, factory tested for leaks. Piping package shall be shipped factory installed.

2.3 UNIT HEATERS

- A. General: Furnish and install Unit Heaters where indicated on the plans and in the specifications, with required mounting components and accessories. All units shall be capable of meeting or exceeding the scheduled capacities for heating and air delivery. Units shall be ETL certified for the United States and Canada in compliance with UL/ANSI Standard 1995 and CSA C22.2 No. 236-95.
- B. Construction: All units shall have panels fabricated of not less than 18-ga cold rolled steel and consist of top/back and side halves. Both halves are joined on top and back with hex-head screws. Top casing is furnished with threaded hanger connections for suspension of unit. Fan venture is die-formed on back half.
1. Casing on all vertical units are top and bottom pieces joined by corners and additional hardware. Top casing is furnished with threaded hanger connections for suspension of unit.
 2. Units shall be equipped with horizontal, individually adjustable louvers.
- C. Painted Finish: All painted cabinet exterior panels shall be finished with a standard textured gray epoxy powder coat paint.
- D. Power: Units shall not exceed the scheduled power consumption.
- E. Motor: Motors shall be 2-speed, permanent split-capacitor, totally enclosed, permanently lubricated bearing type with automatic reset integral thermal overload protection, designed to handle up to 104°F maximum constant ambient temperature. Shaded pole motors are not acceptable. Single speed motors are not acceptable.
1. Provide a solid-state variable speed controller.
- F. Fan: Fans shall have non-conducting, spark-proof aluminum blades, with a steel hub. Each fan blade is balanced and designed specifically for the unit in which it is installed to assure maximum air delivery and quiet operation.
- G. Fan Guard: Fan guard shall be finger-proof, constructed of welded steel rod and finished with a standard black epoxy powder coat paint. Units mounted below 8' from the floor must be equipped with an OSHA fan guard to meet ETL and OSHA requirements.
- H. Coils: Heating coil is designed for either 2-pipe stem or hot water heating system. Coils shall have 1/2" nominal diameter seamless copper tubes and shall be mechanically expanded to provide an efficient, permanent bond between the tube and integral collar of the aluminum fin. Minimum copper tube thickness shall be 0.028".
1. Fins shall be die-formed and have a high efficiency aluminum surface optimized for heat transfer, air pressure drop and carryover. Minimum fin thickness shall be 0.010". Lanced fins shall not be acceptable. Fins are continuous across width and depth of coil and are vertically oriented to resist collection of dirt and foreign particles.
 2. Coils are of non-ferrous construction and serpentine design for RH-18 and RH-24. All other

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units incorporate brazed steel header tubes. RH-18 through RH-86 units have 3/4" female threaded NPT, brass header connections while all other units have male threaded NPT connections.

3. All coils shall be tested at 275-psig air pressure under water and rated for a maximum 220-psig water or 150-psig steam and 375°F. Coils have CRN pressure vessel certification for Ontario and Quebec Provinces.

- I. Electrical: Units shall be furnished with single point power connection. Provide an electrical junction box for motor and other electrical terminations.
 1. Option: Provide a service disconnect switch to isolate power from the unit during maintenance.
 2. Units shall be manufactured in accordance with ISO 9001:2008 standards established and maintained by Zehnder Rittling.

2.4 CONVECTORS (FT-1)

- A. Manufacturers:
 1. Sterling – Basis of Design
 2. Acceptable substitutions:
 - a. Rittling
 - b. Sigma
 - c. Slant Fin
 - d. Vulcan Radiator
- B. Enclosure: Flat Top extruded 16-ga aluminum pencil proof outlet grille. Enclosure shall be constructed of 14-ga corrosion resistant steel in 12" tall enclosure.
- C. Element: 3/4" copper tube, 3-1/4" square by 0.02" thick aluminum fins at 40 fins/foot.
- D. Performance: Unit lengths and capacity as indicated on the drawing schedule.
- E. Custom color shall be selected by the architect.

2.5 VRF HEAT PUMP SYSTEM

- A. SYSTEM DESCRIPTION HEAT PUMP (HEAT/COOL MODEL)
 1. Per the equipment schedule on the drawings, the variable capacity, heat pump air conditioning system basis of design is Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system.
 2. Acceptable alternative manufacturers, assuming compliance with these equipment specifications, are Panasonic, and Hitachi. Contractor bidding an alternate manufacturer does so with full knowledge that that manufactures product may not be acceptable or approved and that contractor is responsible for all specified items and intents of this document without further compensation.
- B. OUTDOOR UNITS
 1. General:
 - a. The outdoor unit modules shall be air-cooled, direct expansion (DX), multi-zone units used specifically with VRF components described in this section and Part 5 (Controls). The outdoor unit modules shall be equipped with a single compressor which is inverter-driven and multiple circuit boards—all of which must be manufactured by the branded VRF manufacturer. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
 - b. Outdoor unit systems may be comprised of multiple modules with differing capacity if a brand other than basis of design is proposed. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.

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- c. Outdoor unit shall have a sound rating no higher than 68 dB(A) individually or 69.5 dB(A) twinned. Units shall have a sound rating no higher than 55 dB(A) individually or 55.5 dB(A) twinned while in night mode operation. Units shall have 5 levels sound adjustment via dip switch selectable fan speed settings. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
 - d. Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.
 - e. The outdoor unit shall have the capability of installing the main refrigerant piping through the bottom of the unit.
 - f. The outdoor unit shall have an accumulator with refrigerant level sensors and controls. Units shall actively control liquid level in the accumulator via Linear Expansion Valves (LEV) from the heat exchanger.
 - g. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
 - h. VRF system shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.
 - i. The outdoor unit shall be capable of guaranteed operation in heating mode down to -25F ambient temperatures and cooling mode up to 126°F without additional restrictions on line length & vertical separation beyond those published in respective product catalogs. Models with capacity data for required temperature range published as "for reference only" are not considered capable of guaranteed operation and are not acceptable. If an alternate manufacturer is selected, any additional material, cost, and labor to meet ambient operating range and performance shall be incurred by the contractor.
 - j. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.
 - k. Unit must defrost all circuits simultaneously in order to resume full heating more quickly during extreme low ambient temperatures (below 23F). Partial defrost, also known as hot gas defrost which allows reduced heating output during defrost, is permissible only when ambient temperature is above 23F.
 - l. While in hot gas defrost the system shall slow the indoor unit fan speed down to maintain a high discharge air temperature, systems that keep fan running in same state shall not be allowed as they provide an uncomfortable draft to the indoor zone due to lower discharge air temperatures.
2. Unit Cabinet:
- a. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
 - b. Panels on the outdoor unit shall be scratch free at system startup. If a scratch occurs the salt spray protection is compromised and the panel should be replaced immediately.
3. Fan:
- a. Each outdoor unit module shall be furnished with direct drive, variable speed propeller type fan(s) only. Fans shall be factory set for operation at 0 in. WG external static pressure, but capable of normal operation with a maximum of 0.32 in. WG external static pressure via dipswitch.
 - b. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
 - c. All fans shall be provided with a raised guard to prevent contact with moving parts.
4. Refrigerant and Refrigerant Piping:
- a. R410A refrigerant shall be required for systems.
 - b. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

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- c. Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the VRF equipment manufacturer and installed in accordance with manufacturer recommendations.
- d. All refrigerant piping must be insulated with ½" closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.
- e. Refrigerant line sizing shall be in accordance with manufacturer specifications.
- 5. Coil:
 - a. Outdoor Coil shall be constructed to provide equal airflow to all coil face surface are by means of a 4-sided coil.
 - b. Outdoor Coil shall be elevated at least 12" from the base on the unit to protect coil from freezing and snow build up in cold climates. Manufacturer's in which their coil extends to within a few inches from the bottom of their cabinet frame shall provide an additional 12" of height to their stand or support structure to provide equal protection from elements as Mitsubishi Electric basis of design. Any additional support costs, equipment fencing, and tie downs required to meet this additional height shall be responsibility of Mechanical Contractor to provide.
 - c. The outdoor heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction. The coil fins shall have a factory applied corrosion resistant finish. Uncoated aluminum coils/fins are not allowed.
 - d. The coil shall be protected with an integral metal guard.
 - e. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
 - f. Unit shall have prewired plugs for optional panel heaters in order to prevent any residual ice buildup from defrost. Panel heaters are recommended for operating environments where the ambient temperature is expected to stay below -1F for 72 hours.
 - g. Condenser coil shall have active hot gas circuit direct from compressor discharge on lowest coil face area to shed defrost condensate away from coil and protect from Ice formation after returning to standard heat pump operation. While in Heat Pump operation this lower section of the Outdoor Evaporator coil shall continually run hot gas from the compressor discharge to protect the coil from ice buildup and coil rupture. Manufacturers who do not have an active hot gas circuit in the lower section of the Outdoor coil to protect coil from freezing shall not be allowed to bid on project in markets where the outdoor unit will see temperatures below freezing.
- 6. Compressors:
 - a. Each outdoor unit module shall be equipped with only inverter driven scroll hermetic compressors. Non inverter-driven compressors, which may cause inrush current (demand charges) and require larger generators for temporary power shall not be allowed.
 - b. Each compressor shall be equipped with a multi-port discharge mechanism to eliminate over compression at part load. Manufacturer's that rely on a single compressor discharge port and provide no means of eliminating over compression and energy waste at part load shall not be allowed.
 - c. Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting "belly-band" type crankcase heaters are not allowed. Manufacturers that utilize belly-band crankcase heaters will be considered as alternate only.
 - d. Compressor shall have an inverter to modulate capacity. The capacity for each compressor shall be variable with a minimum turndown not greater than 15%.
 - e. The compressor shall be equipped with an internal thermal overload.
 - f. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
 - g. Manufacturers that utilize a compressor sump oil sensor to equalize compressor oil volume within a single module shall not be allowed unless they actively shut down the system to protect from compressor failure.
- 7. Electrical:
 - a. The outdoor unit electrical power shall be 460 volts, 3-phase, 60 hertz per equipment schedule.
 - b. The outdoor unit shall be controlled by integral microprocessors.

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- c. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
- C. INDOOR UNITS (WALL MOUNTED TYPE)
 - 1. General:
 - a. The wall-mounted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
 - 2. Unit Cabinet:
 - a. All casings, regardless of model size, shall have the same white finish.
 - b. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining are required.
 - c. There shall be a separate back plate which secures the unit firmly to the wall.
 - 3. Fan:
 - a. The indoor fan shall be statically and dynamically balanced to run on a single motor with permanently lubricated bearings.
 - b. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
 - c. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.
 - 4. Filter:
 - a. Return air shall be filtered by means of an easily removable, washable filter.
 - 5. Coil:
 - a. Basis of design indoor units include factory-installed LEV/EEV. Alternative brands which require field-installed, accessory LEV or EEV kits are permissible only with written Engineer and Architect approval for the location of kits being submitted two weeks prior to bid date. EEV kits mounted in cavities inside fire-rated interior walls shall be mounted inside three hour fire rated enclosures with access panels supplied by the manufacturer. Enclosure type and placement require prior approval.
 - b. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
 - c. The coils shall be pressure tested at the factory.
- D. CONTROLS
 - 1. Overview:
 - a. The control system shall consist of a low voltage communication network and a web-based interface. The controls system shall gather data and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
 - b. Furnish energy conservation features such as optimal start, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.
 - c. System shall be capable of email generation for remote alarm annunciation.
 - 2. ELECTRICAL CHARACTERISTICS
 - a. General:
 - 1) Controller power and communications shall be via a common non-polar communications bus and shall operate at 30VDC.
 - b. Wiring:
 - 1) Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
 - 2) Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.
 - c. Wiring Type:

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- 1) Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.
 - 2) Network wiring shall be CAT-5 with RJ-45 connection.
3. CONTROLS NETWORK
 - a. The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using or BACnet® interfaces.
4. CMCN: SIMPLE MA REMOTE CONTROLLER
 - a. The Backlit Simple MA Remote Controller shall be capable of controlling up to 16 indoor units.
 - b. The Backlit Simple MA Remote Controller shall only be used in same group with Wireless MA Remote Controllers or with other Backlit Simple MA Remote Controllers, with up to two remote controllers per group.
 - c. Control Features:
 - 1) ON/OFF: Run and stop operation for a single group.
 - 2) Operation Mode: Switches between Cool / Drying / Auto / Fan / Heat / Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the R2/WR2-Series only.
 - 3) Temperature Setting: Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit. Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.
 - 4) Fan Speed Setting: Available fan speed settings depending on indoor unit.
 - 5) Air Flow Direction Setting: Air flow direction settings vary depending on the indoor unit model.
 - 6) Permit / Prohibit Local Operation: Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter).
 - 7) Display Indoor Unit Intake Temp: Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.
 - 8) Display Backlight: Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)
 - 9) Error: When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed.
 - 10) Set Temperature Range Limit: Set temperature range limit for cooling, heating, or auto mode.
5. CENTRALIZED CONTROLLER (WEB-ENABLED)
 - a. Master Centralized Controller:
 - 1) The Master Centralized Controller shall be capable of controlling a maximum of two hundred (200) indoor units across multiple CITY MULTI outdoor units with the use of three expansion controllers. The Master Centralized Controller shall be approximately 11-5/32" x 7-55/64" x 2-17/32" in size and shall be powered with an integrated 100-240 VAC power supply. The Master Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. When being used alone without the expansion controllers, the Master Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the Master Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the master provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the Master Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

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- 2) All Master Centralized Controllers shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network switch for IP communication to up to three expansion controllers for display of up to two hundred (200) indoor units on the main master centralized controller interface.
- 3) The Master Centralized Controller shall be capable of performing initial settings via the high-resolution, backlit, color touch panel on the controller or via a PC browser using the initial settings.
- 4) Standard software functions shall be available so that the building manager can securely log into each master centralized controller via the PC's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Additional optional software functions of personal browser for PCs and MACs and Energy shall be available but are not included. The Energy Apportionment function shall require a LIC-Charge software license.
- 5) Control Features:
 - a) ON/OFF: Run and stop operation.
 - b) Operation Mode: Indoor unit modes: COOL / DRY / FAN / AUTO / HEAT.
 - c) Temperature Setting: Sets the temperature from 57°F – 87°F depending on operation mode and indoor unit model.
 - d) Fan Speed Setting: Available fan speed settings depend on indoor unit model.
 - e) Schedule Operation: Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available.
 - f) Optimized Start: Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.
 - g) Permit / Prohibit Local Operation: Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Fan Speed, Air Direction and Reset filter).
 - h) Room Temp: Displays the room temperature of the group.
 - i) Error: When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed.
 - j) Outdoor Unit Status: Compressor capacity percentage and system pressure (high and low) pressure.
 - k) Connected Unit Information: MNET addresses of all connected systems.
- b. Expansion Controller:
 - 1) The Expansion Controller shall serve as a standalone centralized controller or as an expansion module to the Master Centralized Controller for the purpose of adding up to 50 indoor units to either the main touch screen interface of the master centralized controller. Up to three (3) expansion controllers can be connected to the master via a local IP network (and their IP addresses assigned on the master) to the master to allow for up to two hundred (200) indoor units to be monitored and controlled from the master interface.
 - 2) The expansion controllers have all of the same capabilities to monitor and control their associated indoor units as the features specified above. Even when connected to the master and configured to display their units on the main controller, the individual indoor units connected to the expansion can still be monitored and controlled from the interface of the expansion. The last command entered will take precedence, whether at the wall controller, the expansion or the master Centralized Controller.
- c. Non Touch Screen, Networked Centralized Controller:
 - 1) The Non Touch Screen, Networked Centralized Controller shall be capable of controlling a maximum of 50 indoor units across multiple CITY MULTI outdoor units. The controller shall be approximately 8-1/2"x10" in size and shall be powered by its internal power supply. The controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, free contact interlock configuration and malfunction monitoring. The controller shall have five basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, temperature setting, fan speed setting, and airflow direction setting. Since

the controller provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the controller shall allow the user to define both daily and weekly schedules with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

- 2) All Non Touch Screen, Networked Centralized Controller shall be equipped with two RJ-45 Ethernet port to support interconnection with a network PC and BACnet/IP communication via a closed/direct Local Area Network (LAN). The controller shall be capable of performing initial settings online via a PC using the controller's initial setting browser or online/offline with the Initial Setting Tool
 - 3) Standard software functions shall be available so that the building manager can securely log into each controller via the PC's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Standard software functions shall not expire. Additional optional software functions of personal browser for PCs and MACs and Energy Allocation shall be available. The Energy Allocation function shall require Master Centralized Controller Energy Allocation Integrated System in conjunction with Non Touch Screen, Networked Centralized Controller
 - 4) Control Features:
 - a) ON/OFF: Run and stop operation.
 - b) Operation Mode: Indoor unit modes: COOL / DRY / FAN / AUTO / HEAT.
 - c) Temperature Setting: Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit model. Separate COOL and HEAT mode set points available depending on remote controller and connected mechanical equipment.
 - d) Set Temperature Range Limit: The range of room temperature setting can be limited by the initial setting depending on the indoor unit connected.
 - e) Fan Speed Setting: Available fan speed settings depend on indoor unit model.
 - f) Schedule Operation: Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available.
 - g) Hold: Disables scheduled functions for indoor unit groups and their associated remote controller timers.
 - h) Optimized Start: Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.
 - i) Permit / Prohibit Local Operation: Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Fan Speed, Air Direction and Reset filter).
 - j) Room Temp: Displays the room temperature of the group.
 - k) Room Humidity: Displays the percent relative humidity in the space as sensed by the Smart ME Remote Controller.
 - l) Occupancy Sensor: Displays the occupancy icon on the group icon in the condition list page when the room is occupied (blue) or vacant (gray).
 - m) Brightness Sensor: Displays the brightness icon on the group icon in the condition list when the space is determined to be bright (yellow) or dark (gray).
 - n) Error: When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed.
 - o) M-Net: The "M-NET" LED lights, when AC power supply is turned ON. The LED blinks while M-NET is communicating.
6. GRAPHICAL USER INTERFACE
- a. Integrated Centralized Control Web System (ICCW)
 - 1) The Graphical User Interface (Integrated Centralized Control Web) shall require a field supplied PC or Tablet.
 - 2) The Integrated Centralized Control Web System (ICCW) interface shall enable the user to control multiple networked central controllers and shall provide additional functions such as energy apportionment from a single network PC configured with the Charge Calculation Tool. The ICCW shall be capable of controlling up to forty networked Centralized Controllers with a maximum of 2,000 indoor units across multiple CITY MULTI outdoor units. The ICCW shall

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be required if the user wants to simultaneously control more than 1 Centralized Controllers from a single PC or tablet using a single web browser session. Licensing per function, per Centralized Controller shall be required for the ICCW. Optional software features shall be available through the ICCW including energy apportionment and personalized web. These optional software features shall require the ICCW, advance purchase from the customer, and licensing from ICCW

3) Control Features:

- a) ON/OFF: The units can turn ON and OFF for all floors or in a block, floor, or group of units.
- b) Operation Modes: The operation mode can be switched between COOL, DRY, FAN, AUTO, and HEAT for all floors or in a block, floor, or group of units.
- c) Temperature Setting: Sets the temperature for a single group. Range of Temperature setting from 57°F – 87°F depending on operation mode and indoor unit model. Separate COOL and HEAT mode set points available depending on remote controller and connected mechanical equipment.
- d) Fan Speed: The fan speed can be set to four stages for all floors or in a block, floor, or group of units.
- e) Air Direction: The air direction can be set in four vertical directions or to swing for all floors or in block, floor, or group of units. (The selectable air direction differs according to the model.)
- f) Local Operation Prohibit: The items for which operation with the local remote controller are to be prohibited can be selected for all floors or in a block, floor, or group of units. (The items that can be prohibited are ON/OFF, operation mode, set temperature and filter sign reset.)
- g) Annual / Weekly Schedule: The annual/weekly schedule function can be used by registering the license. Two settings, such as seasonal settings for summer and winter, can be saved.
- h) History: Up to 3,000 items for the error history and up to 10,000 items for operation history can be saved. Each history file can be output as a daily report or monthly report in CSV format. (The operation history consists only of the operations carried out with the ICCW and is limited to some limited operation items.)
- i) Operation Time Monitor: The cumulative operation time of each indoor unit can be viewed or output as a CSV format file. (This function is valid only when the charging function license is registered.)
- j) Filter Sign Display Mask: The filter sign display at the remote controllers can be disabled.
- k) Set Temperature Limit: The set temperature lower limit can be set for cooling and the upper limit for heating. (ME remote controller required.)

7. CMCN: SYSTEM INTEGRATION

a. BACnet® Integration:

- 1) The Mitsubishi Electric Cooling & Heating BACnet® hardware, which is built into all networked central controllers, shall be compliant with BACnet® Protocol (ANSI/ASHRAE 135-2010) and be Certified by the (BTL) BACnet® Testing Laboratories. The BACnet® interface shall support BACnet Broadcast Management (BBMD). The BACnet® interface shall support a maximum of 50 indoor units. Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address.
- 2) Licenses:
 - a) LIC-BACnet Master: Master Controller license for Master Centralized Controller and Non Touch Screen, Networked Centralized Controller.
 - b) LIC-BACnet Expansion: Expansion Controller license for Expansion Controller and Non Touch Screen, Networked Centralized Controller.
- 3) LIC-BACnet Specifications:
 - a) Control up to 50 groups.
 - b) 1 to 16 indoor units can be collectively controlled in a group.
 - c) Supports dual set point functionality (connected model dependent).
 - d) BTL Compliant.
 - e) BACnet communication specifications are based on ANSI/ASHRAE

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- Standards 135-2010.
- 4) BACnet Point List (Object List):
 - a) On Off Setup
 - b) On Off State, Number of ON/OFF, Cumulative operation time
 - c) Alarm Signal (4-digit error code)
 - d) Error Code
 - e) Operational Mode Setup
 - f) Operational Mode State
 - g) Fan Speed Setup
 - h) Fan Speed State
 - i) Room Temp
 - j) Set Temp
 - k) Set Temp Cool
 - l) Set Temp Heat
 - m) Prohibition On Off
 - n) Prohibition Mode
 - o) Prohibition Set Temperature
 - p) M-NET Communication State
 - q) System Forced Off
 - r) Air Direction Setup
 - s) Air Direction State
 - t) Set High Limit Setback Temp
 - u) Set Low Limit Setback Temp
 - v) System Alarm Signal (4-digit error code)
 - w) PI Controller Alarm Signal (4-digit error code)

2.6 DUCTLESS SPLIT SYSTEM UNITS (AC/CU)

- A. Manufacturer:
 - 1. Mitsubishi (Basis of Design)
 - 2. Acceptable Substitutes:
 - a. Hitachi
 - b. Panasonic
- B. Outdoor Units (Mitsubishi PUZ)
 - 1. General:
 - a. The PUZ Series outdoor units are specifically designed to work with the wall mounted, ducted, 4-way cassette, ceiling suspended and multi-position air handler indoor units. The connected indoor unit shall be of the same capacity as the outdoor unit. The outdoor units must have a thermally fused powder coated finish. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.
 - b. If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.
 - c. Outdoor unit shall have a sound rating no higher than 53 dB(A). If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
 - d. Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.
 - e. The outdoor unit shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.
 - f. The outdoor unit shall be capable of guaranteed operation in heating mode down to -13°F ambient temperatures and cooling mode up to 115°F without additional restrictions on line length & vertical separation beyond those published in respective product catalogs. Models with capacity data for required temperature range published as "for reference only" are not considered capable of guaranteed operation and are not acceptable. If an alternate manufacturer is selected, any additional material, cost, and

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- labor to meet ambient operating range and performance shall be incurred by the contractor.
- g. The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized wind baffle. The wind baffle shall allow for continuous cooling to 0FDB without any additional modifications to the unit.
2. Unit Cabinet:
- a. The casing shall be fabricated of galvanized steel, bonderized, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. Assembly hardware shall be cadmium plated for weather resistance.
- b. Cabinet color shall be Munsell 3Y 7.8/1.1.
- c. Easy access shall be afforded to all serviceable parts by means of removable panel sections.
- d. Two (2) mild steel mounting feet, traverse mounted across the cabinet base pan, welded mount, providing four (4) slotted mounting holes shall be furnished. Assembly shall withstand lateral wind gust up to 155 MPH to meet applicable weather codes. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
3. Fan:
- a. 1, 1.5, 2 and 2.5 ton units shall be furnished with a single direct drive propeller type fan. 3, 3.5 ton units shall be furnished with a two (2) direct drive propeller type fans.
- b. The outdoor unit fan motor(s) shall be a direct current (DC) motor and have permanently lubricated bearings.
- c. The fan motor shall be mounted for quiet operation.
- d. The fan shall be provided with a raised guard to prevent contact with moving parts.
- e. The outdoor unit shall have horizontal discharge airflow.
4. Refrigerant and Refrigerant Piping:
- a. R410A refrigerant shall be required for systems.
- b. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
- c. Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the equipment manufacturer and installed in accordance with manufacturer recommendations.
- d. All refrigerant piping must be insulated with ½" closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.
- e. Refrigerant line sizing shall be in accordance with manufacturer specifications.
5. Coil:
- a. The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
- b. The coil shall be protected with an integral metal guard.
- c. Refrigerant flow from the outdoor unit shall be regulated by means of an electronically controlled, precision, linear expansion valve.
- d. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1" thick insulation shall have a Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102.
- e. All refrigerant connections between outdoor and indoor units shall be flare type.
6. Compressor:
- a. The compressor shall be a high performance, hermetic, inverter driven, variable speed, dual rotary type manufactured by Mitsubishi Electric Corporation.
- b. The compressor motor shall be direct current (DC) type equipped with a factory supplied and installed inverter drive package.
- c. The compressor will be equipped with internal thermal overload protection.

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- d. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used.
 - e. Filters, sight glasses, and traps shall not be used, and no additional refrigerant oil shall be required.
 - f. The compressor shall be mounted so as to avoid the transmission of vibration.
 - g. The outdoor unit shall have an accumulator and high pressure safety switch.
 - 7. Electrical:
 - a. The outdoor unit electrical power supply shall be 208/230 volts, 1-phase, 60 hertz.
 - b. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
 - c. The outdoor unit shall be controlled by microprocessors located in the indoor unit and outdoor unit. A 12 to 24 volt DC data stream shall communicate between the units providing all necessary information for full function control.
 - d. The outdoor unit shall be equipped with Pulse Amplitude Modulation (PAM) compressor inverter drive control for maximum efficiency with minimum power consumption.
- C. Indoor Units (PKA Wall Mounted Units)
 - 1. General:
 - a. The wall-mounted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
 - 2. Unit Cabinet:
 - a. All casings, regardless of model size, shall have the same Munsell 1.0Y 9.2/0.4 white finish.
 - b. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining are required.
 - c. There shall be a separate back plate which secures the unit firmly to the wall.
 - 3. Fan:
 - a. The indoor fan shall be statically and dynamically balanced to run on a single motor with permanently lubricated bearings.
 - b. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
 - c. An integral, motorized, multi-position, horizontal air sweep vane shall provide for uniform air distribution, up and down. Vane shall have 5 selectable positions plus AUTO (Controls position based upon mode, microprocessor shall automatically determine the vane angle to provide the optimum room temperature distribution) and SWING (Continuously moves up and down). In OFF mode the horizontal vane shall return to the closed position.
 - d. The indoor unit shall include an AUTO fan setting capable of maximizing energy efficiency by adjusting the fan speed based on the difference between controller set-point and space temperature. The indoor fan shall be capable of five (5) speed settings, Low, Mid1, Mid2, High and Auto.
 - 4. Filter:
 - a. Return air shall be filtered by means of an easily removable, washable filter.
 - 5. Coil:
 - a. The indoor unit coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - b. The tubing shall have inner grooves for high efficiency heat exchange.
 - c. All tube joints shall be brazed with silver alloy.
 - d. The coils shall be pressure tested at the factory.
 - e. A sloped, corrosion resistant condensate pan with drain shall be provided under the coil.
- D. Controls
 - 1. Overview:
 - a. The control system shall consist of a minimum of one microprocessor on each indoor unit and one in the outdoor unit, communicating via A-Control data over power

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transmission. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired or wireless controller, providing emergency operation and controlling the outdoor unit. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Indoor units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.

- b. 5. For A-Control, a three (3) conductor 14 gauge AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units. If code requires a disconnect mounted near the indoor unit, a TAZ-MS303 3-Pole Disconnect shall be used – all three conductors must be interrupted.
 - c. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.
2. Remote Controller (Deluxe Wired MA Remote Controller):
- a. The Deluxe Wired MA Remote Controller shall be capable of controlling up to 16 indoor units (defined as 1 group).
 - b. The Deluxe Wired MA Remote Controller shall only be used in same group with another Deluxe Wired MA Remote Controller, with up to two remote controllers per group.
 - c. Features:
 - 1) ON/OFF: Run and stop operation for a single group.
 - 2) Operation Mode: Indoor unit modes: COOL / DRY / FAN / AUTO / HEAT.
 - 3) Temperature Setting: Sets the temperature from 40°F – 87°F depending on operation mode and indoor unit model.
 - 4) Fan Speed Setting: Available fan speed settings depend on indoor unit model.
 - 5) Air Flow Direction Setting: Air flow direction settings vary depending on the indoor unit model.
 - 6) Permit / Prohibit Local Operation: Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Fan Speed, Air Direction and Reset filter).
 - 7) Room Temp: Displays the room temperature of the group.
 - 8) Display Backlight: Pressing a button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)
 - 9) Error: When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed.
 - 10) Set Temperature Range Limit: Set temperature range limit for cooling, heating, or auto mode.
 - 11) Schedule: Set up to 8 operations per day, 7 days per week. Operations include time on/off, mode and room temperature set point.
3. CMCN Remote Controllers: System Integration:
- a. The CMCN shall be capable of supporting integration with Building Management Systems (BMS).

2.7 RADIANT CEILING HEATING PANELS

- A. Manufacturer:
1. QMark CP Series (Basis of Design)
 2. Acceptable Substitutes:
 - a. Berko
 - b. Indeeco
 - c. Markel
- B. Construction:
1. Panels:
 - a. Front: 22 gauge galvanized or aluminized steel
 - b. Back: 24 gauge galvanized or aluminized steel
 2. Wire: Internal 200°C, 14 gauge, Teflon insulated.
 3. Element: Encapsulated cassette element providing uniform temperature distribution over the entire panel surface.
 4. Insulation: Minimum 1-inch, 1 pound density, high temperature fiberglass.

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5. Surface: Crystalline surface coating with white finish.
- 6.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment per industry standards, applicable codes, and manufacturer's instructions.
- B. AHUs shall not be used for temporary heating, cooling or ventilation prior to complete inspection and startup performed per this specification.
- C. Install AHUs on a concrete pad, roof curb, or structural steel base, as shown on drawings.
- D. Install AHUs with manufacturer's recommended clearances for access, coil pull, and fan removal.
- E. One complete set of filters shall be provided for testing, balancing, and commissioning. Provide second complete set of filters at time of transfer to owner.
- F. Install AHU plumb and level. Connect piping and ductwork according to manufacturer's instructions.
- G. Install seismic restraints and anchors per applicable local building codes. Refer to specification Section 230548 (15240 / 15070) for product and installation requirements.
- H. Install pipe chases per manufacturer's instructions.
- I. Insulate plumbing associated with drain pan drains and connections.
- J. Install insulation on all staggered coil piping connections, both internal and external to the unit.
- K. Install convectors and cabinet heaters as indicated. Coordinate to assure correct recess size for recessed convectors.
- L. Protect units with protective covers during balance of construction.

3.2 FIELD QUALITY CONTROL

- A. AHU shall be stored as per manufacturer's written recommendations.
- B. AHUs shall be stored indoors in a warm, clean, dry place where unit(s) will be protected from weather, construction traffic, dirt, dust, water and moisture. If unit(s) to be stored for more than 6 months, manufacturer's instruction for long-term storage shall be followed.
- C. Rig and lift units shall be according manufacturer's instructions

3.3 AHU INSPECTION

- A. Hire manufacturer's factory-trained and factory-employed service technician to perform an inspection of unit and installation prior to startup. Technician shall inspect and verify the following as a minimum:
 1. Damage of any kind
 2. Level installation of unit
 3. Proper reassembly and sealing of unit segments at shipping splits.
 4. Tight seal around perimeter of unit at the roof curb
 5. Installation of shipped-loose parts, including filters, air hoods, bird screens and mist eliminators.
 6. Completion and tightness of electrical, ductwork and piping

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7. Tight seals around wiring, conduit and piping penetrations through AHU casing.
8. Supply of electricity from the building's permanent source
9. Integrity of condensate trap for positive or negative pressure operation
10. Condensate traps charged with water
11. Removal of shipping bolts and shipping restraints
12. Sealing of pipe chase floor(s) at penetration locations.
13. Tightness and full motion range of damper linkages operate manually
14. Complete installation of control system including end devices and wiring
15. Cleanliness of AHU interior and connecting ductwork
16. Proper service and access clearances
17. Proper installation of filters
18. Filter gauge set to zero.

3.4 INSPECTION AND ADJUSTMENT: AHU FAN ASSEMBLY

- A. Hire the manufacturer's factory-trained and factory-employed service technician perform an inspection of the AHU fan assembly subsequent to general AHU inspection and prior to startup. Technician shall inspect and verify the following as a minimum:
 1. Fan isolation base and thrust restraint alignment
 2. Tight set screws on pulleys, bearings and fan
 3. Tight fan bearing bolts
 4. Tight fan and motor sheaves
 5. Tight motor base and mounting bolts
 6. Blower wheel tight and aligned to fan shaft
 7. Sheave alignment and belt tension
 8. Fan discharge alignment with discharge opening
 9. Fan bearing lubrication
 10. Free rotation of moving components rotate manually
- B. Manufacturer shall dynamically balance fan/motor/base assembly.
 1. Balance constant volume fan assemblies at design RPM.
 2. Balance variable volume fan assemblies from 10% to 100% of design RPM.
 3. Take filter-in measurements in the horizontal and vertical axes on the drive and opposite-drive sides of fan shafts.
 4. Constant speed fan vibration limits: filter-in measurements shall not exceed 4 mils.
 5. Variable speed fan vibration limits: filter -in measurements shall not exceed 7 mils.
- C. Manufacturer shall hi-pot test wiring intended to carry voltages greater than 30VAC.

3.5 DOCUMENTATION

- A. Provide Installation Instruction Manual, & Startup checklist in the supply fan section of each unit.
- B. Provide six copies of Spare Parts Manual for owner's project system manual.

3.6 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- C. Install new filters.

END OF SECTION 23 08 35

SECTION 23 08 60 - VENTILATION EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Energy Recovery Ventilator
- B. Ceiling Mounted Centrifugal Exhaust Fans

1.2 REFERENCES

- A. AMCA 99 - Standards Handbook
- B. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes
- C. AMCA 261 - Directory of Products Licensed to Bear the AMCA Certified Ratings Seal
- D. NFPA 70 - National Electrical Code
- E. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease Vapors from Commercial cooking Equipment
- F. UL 705 - Power Ventilators

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 23 00 10.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, sound power levels at rated capacity, and electrical characteristics and connection requirements.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Refer to Schedules on Drawing M4.1 for Equipment Manufacturers and Model Numbers.

2.2 ENERGY RECOVERY VENTILATORS (ERV)

A. MANUFACTURERS

- 1. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
 - a. Greenheck Fan Corporation

B. MANUFACTURERED UNITS

- 1. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, energy wheel, motorized intake damper, motorized exhaust damper, frost control, filter assembly for intake and exhaust air, supply air blower assembly, exhaust air blower assembly and an electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.

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C. CABINET

1. Materials: Formed double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - a. Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish.
 - b. Internal assemblies: 18 gauge, galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
2. Access doors shall be hinged.
3. Shall have factory-installed duct flanges on all duct openings.
4. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - a. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - 1) Thickness: 1 inch (25 mm).
 - 2) Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - 3) Location and application: Full coverage of entire cabinet exterior to include walls, roof and floor of unit. Insulation shall be of semi-rigid type and installed between inner and outer shells of all cabinet exterior components.
5. Energy wheel: Energy wheel shall be of total enthalpy, rotary air-to-air type and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned urethane drive belt with a five year warranty. The wheel media shall be a polymer film matrix in a stainless steel framework and be comprised of individual segments that are removable for servicing. Non-segmented energy wheels are not acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and shall be designed and constructed to permit cleaning and servicing. The energy wheel is to have a five year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.
6. Supply Air and Exhaust Air blower assemblies: Blower assemblies consist of an electric motor and a belt driven blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on 1.125 inch thick neoprene vibration isolators.
7. Control panel / connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections.
8. Frost control: modulating wheel.
9. Modulating frost control. Control system shall include an outdoor air thermostat and pressure sensor on the wheel assembly to initiate frost control sequence.
10. Motorized dampers / Exhaust Air, Intake Air, Motorized dampers of low leakage type shall be factory installed.

D. BLOWER

1. Blower section construction, Supply Air and Exhaust Air: Belt drive motor and blower shall be assembled onto a 14 gauge galvanized steel platform and must have neoprene vibration isolation devices.
2. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
3. Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.
4. Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.
5. Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

E. MOTORS

1. General: Blower motors greater than 3/4 horsepower shall be "NEMA Premium" unless otherwise indicated. Minimum compliance with EPA minimum energy-efficiency standards for single speed ODP and TEFC enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be

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- supplied with an adjustable drive pulley. Comply with requirements in Division 23 05 13, matched with fan load.
 - 2. Fan motors shall be 60 cycle, 3 phase 460 volts.
 - F. UNIT CONTROLS
 - 1. Sensors
 - a. Dirty filter sensor
 - G. FILTERS
 - 1. Units shall have permanent metal filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the intake air stream and MERV 8 filters in the exhaust air stream.
- 2.3 DIRECT DRIVE PREMIUM CEILING MOUNTED CENTRIFUGAL EXHAUST FANS (EF)
- A. General Description:
 - 1. Base fan performance at standard conditions (density 0.075 Lb/ft³)
 - 2. Ceiling mounted applications
 - 3. Performance capabilities up to 1,600 cubic feet per minute (cfm) and static pressure to 0.75 inches of water gauge
 - 4. Fans are available in nineteen sizes (50 - 1550 unit sizes)
 - 5. Maximum operating temperature is 130 Fahrenheit (54.4 Celsius)
 - 6. Sound levels as low as 0.7 AMCA sonesSound levels as low as <0.3 AMCA sones
 - 7. UL/cUL listed for above bathtub exhaust
 - 8. Fans are UL/cUL listed 507 - Electric Fans
 - 9. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number
 - B. Wheel:
 - 1. Forward curved centrifugal wheel
 - 2. Constructed of galvanized steel or calcium carbonate filled polypropylene
 - 3. Statically and dynamically balanced in accordance with AMCA Standard 204-05.
 - C. Motors:
 - 1. AC Induction Motor
 - a. Motor enclosures: Totally enclosed air over: (TEAO)- designed to be used solely in the airstream, constructed with a dust tight cover and a aerodynamic body which relies upon the strong airflow of the fan to cool the motor, not suitable for hazardous environments.
 - b. Motors shall be permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase.
 - c. Motor shall be mounted on vibration isolators and be accessible for maintenance.
 - d. Thermal overload Protection.
 - D. Housing:
 - 1. Constructed of heavy gauge galvanized steel
 - 2. Interior shall be lined with 0.5" of acoustical insulation
 - 3. Profile as low as 10-1/2"
 - E. Spring Loaded Aluminum Backdraft Damper:
 - 1. Prevents air from entering back into the building when fan is off
 - 2. Eliminates rattling or unwanted backdrafts.
 - F. Outlet:
 - 1. Type of outlet: Round
 - 2. Field rotatable from horizontal to vertical discharge
 - 3. Shall include an aluminum backdraft damper
 - G. Mounting Brackets: Fully adjustable for multiple installation conditions
 - H. Grille:

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1. Type: Designer - Calcium-carbonate, Factory Standard
 2. Constructed of aluminum non-yellowing, aluminum shall be factory standard.
- I. External Electrical Accessories:
1. Eliminates removing the motor pack which saves time on installation.
- J. Options and Accessories:
1. Vibration Isolation:
 - a. Available for suspended installations
 - b. Includes pre-punched hole for ease of installation and shall have all hardware to mount one unit.

PART 3 - EXECUTION

3.1 ENERGY RECOVERY VENTILATORS

- A. Examination
1. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.
 2. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.
 3. Proceed with installation only after all unsatisfactory conditions have been corrected.
- B. Installation
1. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.
- C. Connections
1. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
 - a. Duct installation and connection requirements are specified in Division 23 of this document.
 - b. Electrical installation requirements are specified in Division 26 of this document.
- D. Field Quality Control
1. Manufacturer's Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A/E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.
- E. Start-up Service
1. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.
- F. Demonstration and Training
1. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

3.2 EXHAUST FAN

- A. Manufacturer's Instructions
1. Compliance: Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions.
- B. Examination

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1. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected
- C. Preparation
 1. Ensure roof openings are square, accurately aligned, correctly located, and in tolerance
 2. Ensure duct is plumb, sized correctly, and to proper elevation above roof deck. Install duct as specified in Ductwork Systems (Division 23)
- D. Installation
 1. Install fan system as indicated in the Installation, Operation and Maintenance Manual (IOM) and contract drawings
 2. Install fans in accordance with manufacturer's instructions
- E. System startup
 1. Refer to Installation, Operation, and Maintenance Manual (IOM)
- F. Cleaning
 1. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction
- G. Protection
 1. Protect installed product and finished surfaces from damage during construction
 2. Protect installed exhaust fans to ensure that, except for normal weathering, fans will be without damage or deterioration at time of substantial completion

END OF SECTION 23 08 60

SECTION 23 08 90 - DUCTWORK SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metal Ductwork
- B. Nonmetal Ductwork
- C. Duct Cleaning
- D. Air Turning Devices/Extractors
- E. Backdraft Dampers
- F. Duct Access Doors
- G. Fire Dampers
- H. Flexible Duct Connections
- I. Volume Control Dampers
- J. Diffusers
- K. Registers/Grilles
- L. Louvers

1.2 REFERENCES

- A. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles
- B. ASTM A 525 - General Requirements for Steel Sheet, Zinc- Coated (Galvanized) by the Hot-Dip Process
- C. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality
- D. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate
- E. NFPA 90A - Installation of Air Conditioning and Ventilating Systems
- F. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment
- G. SMACNA - HVAC Air Duct Leakage Test Manual
- H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible
- I. SMACNA - Fibrous Glass Duct Construction Standards
- J. UL 181 - Factory-Made Air Ducts and Connectors
- K. UL 33 - Heat Responsive Links for Fire-Protection Service

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- L. UL 555 - Fire Dampers and Ceiling Dampers
- M. ASHRAE Handbook - Systems Volume, Chapter "Sound and Vibration Control"
- N. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 23 00 10.
- B. Ductwork:
 - 1. Shop Drawings:
 - a. Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration prior to start of work for kitchen hood exhaust systems.
 - b. The contractor shall submit for checking and approval, copies of his shop drawings of ductwork for the main trunk duct systems and must receive approval of the Architects before any fabrication upon this ductwork is begun.
 - 2. Product Data: Provide data for duct materials and duct connectors.
- C. Ductwork Accessories:
 - 1. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors, fire dampers, duct silencers, etc.
 - 2. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, fire dampers, duct silencers, etc.
 - 3. Manufacturer's Installation Instructions: Indicate for fire dampers and combination fire and smoke dampers.
- D. Air Outlets and Inlets:
 - 1. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- B. Test and rate louver performance in accordance with AMCA 500.

1.5 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A and NFPA 96 standards.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

- A. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having G60 zinc coating of in conformance with ASTM A90.
- B. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061- T6 or of equivalent strength.
- C. Stainless Steel Ducts: ASTM A167, Type 304
- D. Insulated Flexible Ducts:
 - 1. Manufacturers:

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- a. Johns Manville Model Micro-Aire J/FLXSL.
 - b. Wiremold Model M-KH.
 - c. Automation Industries Flexible Tubing Div. Model Thermaflex.
2. Flexible round ductwork shall consist of a vinyl coated spring steel helix bonded to a vinyl coated fiberglass liner wrapped with fiberglass wool insulation providing a thermal conductance of 0.23 Btu./hr./sq. ft./0°. Outer jacket shall be reinforced metalized mylar/neoprene laminate. Ducts shall be "Thermaflex" as manufactured by Automation Industries Flexible Tubing Division Type M-KH or type VTKC as manufactured by the Wiremold Company, suitable for an operating temperature from 0°F to 180°F and 2" wg. Clamps, connectors, and the installation shall be as recommended by the manufacturer. Ducts shall be listed by UL under their UL-181 standards as Class 1 air duct and comply with NFPA Standard No. 90A.

2.2 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Provide turning vanes in all elbows. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.
- C. Increase duct sizes gradually, not exceeding 15° divergence wherever possible; maximum 30° divergence upstream of equipment and 45° convergence downstream.
- D. Provide standard 45° lateral wye takeoffs unless otherwise indicated where 90° conical tee connections may be used.
- E. Exposed round and rectangular metal ductwork shall be supplied and prepared for field painting by HVAC Contractor for painting by General Contractor. Color selected by Architect.

- F. Size shall be as follows: Rectangular Duct:

<u>Largest Duct Dimension</u>	<u>Steel U.S. Standard Gauge</u>
Up through 12"	26
13" through 30"	24
30" through 54"	22
55" through 84"	20
84" and above	18

Round Duct (Exhaust System Only)

<u>Largest Dimension</u>	<u>Steel - U.S. Standard Gauge</u>
Up through 8"	26
9" through 22"	24
23" through 36"	22
37" through 50"	20

- G. Double Wall Insulated Round Ducts:

1. Manufacturers:
 - a. United McGill Model Acousti-K27
 - b. Semco
 - c. Monroe Metal Manufacturing
 - d. CWR Sheetmetal
 - e. Eastern Sheetmetal
 - f. MKT Metal Manufacturing
2. Round duct for Supply, Return, Fresh Air Systems shall be United Sheet Metal Acousta-K27 Type P double walled internally insulated duct system with spiral outer duct and perforated metal liner. Fittings shall be Type K with solid metal liners. The outer pressure sheet and inner shall be manufactured from galvanized steel meeting ASTM A-527 in the following minimum gauges. Insulation shall be 1-inch thickness.

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Nom Duct Size	Duct (Outer Shell) (Spiral Duct)	Duct (Inner Shell)	Fitting (Outer)	Fittings (Inner Liner)
3"-12"	26-ga.	24-ga.	20-ga.	20-ga.
13"-24"	24-ga.	24-ga.	20-ga.	20-ga.
25"-34"	22-ga.	24-ga.	20-ga.	20-ga.
35"-48"	20-ga.	24-ga.	18-ga.	20-ga.

H. Exposed round metal ductwork shall be field painted in color selected by Architect.

I. Provide manufactured round ductwork for all exposed round ductwork.

2.3 AIR TURNING DEVICES/EXTRACTORS

A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.4 BACKDRAFT DAMPERS

A. Gravity Backdraft Dampers, Size 18" x 18" (450 x 450 mm) or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturers' standard construction.

B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: 16-ga thick galvanized steel, with blades of maximum 6" width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90° stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

C. Gravity Backdraft Dampers, Size Larger than 18 x 18" (450 x 450 mm), shall consist of: 16 ga insert mount galvanized steel hat channel frame with 5.000" depth; blades from 0.063" thick formed aluminum, eccentrically pivoted; 0.375". square plated steel axles with galvanized steel press-fit ball bearings; damper shall be equipped with pressure activated vinyl blade seals; and internal plated steel blade-to-blade linkage with blade mounted counterbalance weights.

D. Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval showing damper suitable for pressures to 2" wg, velocities to 2,000'/min and temperatures to 180°F. Testing and ratings to be in accordance with AMCA Standard 500D.

2.5 DUCT ACCESS DOORS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

B. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum 1" (25 mm) thick insulation with sheet metal cover.

1. Less Than 12" Square: Secure with sash locks.
2. Up to 18" Square: Provide two hinges and two sash locks.
3. Up to 24" x 48": Three hinges and two compression latches with outside and inside handles.
4. Larger Sizes: Provide an additional hinge.

C. Access doors with sheet metal screw fasteners are not acceptable.

2.6 FIRE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated for dynamic systems.

B. Ceiling Dampers: Galvanized steel, 22-ga frame and 16-ga flap, two layers 0.125" ceramic fiber on top side, with locking clip.

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- C. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations and closure under air flow conditions. Configure with blades out of air stream, similar to Ruskin for dynamic conditions.
- D. Fusible Links: UL 33, separate at 160°F with adjustable link straps for combination fire/balancing dampers.

2.7 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- B. Connector: Fabric crimped into metal edging strip.
- C. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
 - 1. Net Fabric Width: Approximately 2" (50 mm) wide.
 - 2. Metal: 3" wide, 24-ga (0.6 mm thick) galvanized steel.

2.8 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- B. Single Blade (up to 12" high) – 16-ga blade on rod.
- C. Multi-Blade Damper (over 12" high): Fabricate of opposed blade pattern with maximum blade sizes 8" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. End Bearings: Except in round ductwork 12" (300 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- E. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
 - 3. Where rod lengths exceed 30" provide regulator at both ends.

2.9 RECTANGULAR CEILING DIFFUSERS (D, except where otherwise specified below)

- A. Manufacturers:
 - 1. Tuttle & Bailey Model RC
 - 2. Metalaire Series 5000
 - 3. Titus TDV
 - 4. Price SMX/AMS
- B. Type: Square and rectangular, multi-louvered diffuser to discharge air in pattern as indicated on drawings.
- C. Frame: Surface mount type or lay-in grid type.
- D. Fabrication: Steel or aluminum with baked enamel off-white finish where installed in white acoustical tile ceiling or drywall ceiling. Custom color or finish suitable for painting as selected by Architect where non-white acoustical tile or drywall ceiling is installed.
- E. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

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2.10 CEILING EXHAUST AND RETURN REGISTERS/GRILLES (ER, RR, TR)

- A. Manufacturers:
 - 1. Tuttle & Bailey Agitair Model A70D
 - 2. Acceptable equal by Anemostat, Titus, Carnes, Metalaire, Krueger, Price provided specifications are met.
- B. Type: Streamlined blades, 3/4" minimum depth, 3/4" maximum spacing, with blades set at 45° horizontal face.
- C. Frame: 1-1/4" margin with countersunk screw mounting.
- D. Fabrication: Aluminum extrusions, with baked enamel off-white finish where installed in white acoustical tile ceiling or drywall ceiling. Custom color or finish suitable for painting as selected by the Architect where non-white acoustical tile or drywall ceiling is installed.
- E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.
- F. Connection Size: Duct connection size shall be the full face size indicated in the schedule. Round flex duct shall not be acceptable.

2.11 SUPPLY REGISTERS (SR)

- A. Manufacturers:
 - 1. Tuttle & Bailey, AV54 with horizontal blade adjustment (front) and vertical adjustment (rear)
 - 2. Approved equal: Anemostat, Titus, Carnes Metalair, Krueger, Price
- B. Type: Streamlined and individually adjustable blades, 3/4" minimum depth, 3/4" maximum spacing with spring or other device to set blades, vertical face, double deflection.
- C. Frame: 1-1/4" margin with concealed mounting and gasket.
- D. Fabrication: Aluminum extrusions, with color to match attached surface or duct as selected by the Architect.
- E. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Rectangular ductwork shall be galvanized unless otherwise noted.
- B. Provide aluminum ductwork for dishwasher exhaust system.
- C. Install in accordance with manufacturer's instructions.
- D. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- E. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- G. Use double nuts and lock washers on threaded rod supports.
- H. Connect terminal units to supply ducts with 1' maximum length of flexible duct. Do not use flexible duct to change direction.

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- I. Connect diffusers to low pressure ducts with 8' maximum length of flexible duct held in place with strap or clamp. (Concealed areas only.)
- J. Connect flexible ducts to metal ducts with adhesive.
- K. Set plenum doors 6" to 12" above floor. Arrange door swings so that fan static pressure holds door in closed position.
- L. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- M. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- N. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- O. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ductwork in accordance with NFPA 96. Provide minimum 8" x 8" size for hand access, 18" x 18" size for shoulder access, and as indicated. Provide 4" x 4" for balancing dampers only. Review locations prior to fabrication.
- P. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings, and hinges.
- Q. Demonstrate re-setting of fire dampers to Owner's representative.
- R. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- S. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- T. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- U. Support duct silencers independent of ductwork.
- V. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- W. Install diffusers to ductwork with airtight connection.
- X. Paint ductwork visible behind air outlets and inlets matte black.
- Y. HC shall verify equipment connection sizes and locations and transition ductwork size as required.
- Z. Return air registers for each system are sized based on full return air during the unoccupied cycle. During the occupied cycle, return air quantity will be reduced by the amount of outdoor CFM.

3.2 NEW DUCTWORK CLEANING

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

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3.3 SHEET METAL WORK

- A. Provide air duct systems as shown on the drawings. Construction methods, unless otherwise specified, shall conform with the recommendations in the latest edition of the ASHRAE Guide. Unless otherwise noted, ductwork shall be galvanized steel.
- B. All ductwork seams and joints shall be caulked with white silicone caulking and taped before caulking compound cures. In lieu of caulk and tape, ductwork may be sealed with Benjamin Foster #30-02 duct seal or Cadoprene #725 installed per manufacturer's instructions.
- C. For use on ductwork 18" size and larger in any dimension, the system shall consist of angles, corners, PCV cleats, gaskets, and corner clips. Install the system in accordance with the manufacturer's instructions and installation manuals. Joints shall meet SMACNA Type "J" connection for Systems 35 and SMACNA Type "E" for System 25. Duct connection system shall be similar to "Ductmate" by Ductmate Industries, Inc.
- D. All branch connections shall be made in a manner that leaves no exposed liner edges.
- E. No pipe or conduit and no hangers for ceilings or piping shall pass through ducts unless it is impossible to avoid doing so, in which case, the approval of the Architect shall be obtained before proceeding with the work.
- F. Should vibrations occur in ductwork while the system is in operation, this contractor shall install such additional stiffening members as are necessary to overcome this vibration. All ductwork where vibration occurs shall be isolated at points of contact with the building by felt pads neatly and securely held in place. The ductwork at a manually or automatically operated damper shall be reinforced to properly support the damper and prevent vibration. Curved elbows shall have a centerline radius of not less than 1-1/2 times the width of the duct.
- G. All work shall be designed and fabricated to keep resistance losses to a minimum. Use gradual transformation and long radius elbows. Where sharp turns are necessary, the elbow or plenum shall be fabricated with vanes concentric with the inside and outside radii.
- H. Where indicated and where required for proper system air balancing furnish and install opposed blade adjustable volume dampers as hereinafter specified.
- I. Volume dampers are to be key operated opposed blade type and are to be operable from the bottom.

3.4 HANGERS

- A. Ductwork shall be rigidly supported and secured in an approved manner to the structure, reinforced and braced to be free from vibration, rattle and noise. Hangers shall be securely suspended from structure.
- B. Hanger schedule shall be as follows:
 - 1. Duct up to 20" wide: Galvanized band or strap iron not less than 12-ga not less than 1" wide - 8' centers.
 - 2. Ducts 21" to 36" wide: 1-1/2"x1-1/2"x1/8" angle iron and 3/8" threaded rod-8' centers.
 - 3. Ducts 36" wide: 1-1/2"x1-1/2" x 3/16" angle iron and 1/2" threaded rod - 6' centers.

3.5 DUCT ACCESS DOORS AND FIRE DAMPERS

- A. Access doors shall be provided in ductwork and walls and ceilings where required for adjustment of manual dampers and fire dampers. Access doors in walls and/or ceilings shall be furnished by this contractor for installation by others. Access doors must meet fire rating requirements of associated wall or ceiling.
- B. Fire dampers shall in all cases be accessible with suitable means provided for replacing fusible links. Where no other means are available, access doors shall be provided in ductwork.

END OF SECTION 23 08 90

SECTION 23 09 00- ATC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for complete building automation system (also identified as BMS, Direct Digital Control System For HVAC) including all necessary hardware and all operating and applications software as required for the complete performance of the Work, as shown on the Drawings, and as specified herein.
- B. The BMS as described herein shall be provided by NRG Controls. Contact Tom Dunleavy or Jay Franklin (717-939-2400). No substitutes will be accepted.
- C. Related Sections: Related sections include, but shall not be limited to, the following:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Applicable general requirements for electrical Work specified within Divisions 23, 26 Specification Sections apply to this Section.
- D. Network level components of the system – workstations, servers, network controllers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2004. No gateways shall be used for communication to controllers furnished under this section.
- E. At a minimum, provide controls for the mechanical systems reflected in the sequences of operation and shown on the mechanical drawings, including but not limited to the following:
 - 1. Heating Hot Water System: Boilers & Hot Water Pumps
 - 2. Cabinet unit heaters
 - 3. Energy Recovery Ventilators
 - 4. Exhaust Fans
 - 5. Return/Exhaust Air Fans
 - 6. Unit Heaters
- F. Except as otherwise noted, the control system shall consist of all necessary Ethernet Network Controllers, Standalone Digital Control Units, Room Controllers, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
- G. The BAS system supplier shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
- H. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS system supplier and representatives of the Owner will review and check out the system – see System Acceptance and Testing section of this document. At that time, the BAS system supplier shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.
- I. Provide services and manpower necessary for commissioning of the system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative.

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- J. All work performed under this section of the specifications will comply with all governing codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.2 REFERENCES

- A. General, Code Compliance: The code listed below form a part of this Specification to the extent referenced. The codes are referred to in the text by the basic designation only. The edition/revision of the referenced code shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
1. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
 2. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
 3. All wiring shall conform to the National Electrical Code.
 4. All smoke dampers shall be rated in accordance with UL 555S.
 5. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
 6. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.3 DEFINITIONS

- A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.
1. Standard
 - a. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
 - b. AHU: Air Handling Unit
 - c. BACnet: Building Automation Controls Network
 - d. BMS: Building Management System
 - e. DDC: Direct Digital Control
 - f. EIA: Electronic Industries Alliance
 - g. GUI: Graphical User Interface
 - h. HVAC: Heating, Ventilation, and Air Conditioning
 - i. IEEE: Institute Electrical Electronic Engineers
 - j. MER: Mechanical Equipment Room
 - k. PID: Proportional, Integral, Derivative
 - l. VAV: Variable Air Volume Box
 2. Communications and protocols
 - a. ARP: Address Resolution Protocol
 - b. BACnet: Building Automation and Control Networks
 - c. CORBA: Common Object Request Broker Architecture
 - d. CSMA/CD: Carrier Sense Multiple Access/Collision Detect
 - e. DDE: Dynamic Data Exchange
 - f. FTP: File Transfer Protocol
 - g. FTT: Free Topology Transceivers
 - h. HTTP: Hyper Text Transfer Protocol
 - i. IIOP: Internet Inter-ORB Protocol
 - j. IP: Internet Protocol
 - k. LAN: Local Area Network

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- l. LON: Echelon Communication – Local Operating Network
 - m. MS/TP: Master Slave Token Passing
 - n. OBIX: Open Building Information Exchange
 - o. ODBC: Open Database Connectivity
 - p. ORB: Object Request Broker
 - q. SNVT: Standard Network Variables Types
 - r. SQL: Structured Query Language
 - s. UDP: User Datagram Protocol
 - t. XML: eXtensible Markup Language
3. Controllers
- a. ASD: Application Specific Device
 - b. AAC: Advanced Application Controller
 - c. ASC: Application Specific Controller
 - d. CAC: Custom Application Controller
 - e. DCU: Distributed Control Unit
 - f. HRC: Hotel Room Controller
 - g. LCM: Local Control Module
 - h. MC: MicroControllers
 - i. MPC: Multi-purpose Controller
 - j. NC: Network Controller
 - k. PEM: Package Equipment Module
 - l. PPC: Programmable Process Controller
 - m. RC: Room controller
 - n. RPC: Room Purpose Controller
 - o. SDCU: Standalone Digital Control Units
 - p. SLC: Supervisory Logic Controller
 - q. UEC: Unitary Equipment Controller
 - r. VAVDDC: Variable Air Volume Direct Digital Controller
4. Tools and Software
- a. AFDD: Automated Fault Detection and Diagnostic
 - b. APEO: Automated Predictive Energy Optimization
 - c. DR: Demand Response
 - d. CCDT: Configuration, Commissioning and Diagnostic Tool
 - e. BPES: BACnet Portable Engineering Station
 - f. LPES: LON Portable Engineering Station
 - g. POT: Portable Operator's Terminal
 - h. PEMS: Power and Energy Management Software
 - i. MTBF: Mean Time Between Failure

1.4 SYSTEM DESCRIPTION

- A. In accordance with the scope of work, the system shall provide custom mechanical system graphics, floorplan graphics and equipment summary screens, installed on the web-server. The contractor must provide microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.
- B. For this project, the system shall consist of the following components:
 - 1. Administration and Programming Workstation(s): The BAS system supplier shall utilize existing Workstations and software installed at the school district. These workstations shall interface directly with the Network Controllers and control hardware installed under this project.

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2. Web-Based Operator Workstations: The BAS system supplier shall utilize existing Workstations and software installed at the school district. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes.
 3. System shall be Tridium/Niagara N4 Web-Supervisor, utilizing Web-Server hardware/software, and existing LAN infrastructure. All custom graphics and user-defined parameters (trending, scheduling, alarming) shall comply with existing district standards
 4. Ethernet-based Network Router and/or Network Controller(s): The BAS system supplier shall furnish needed quantity of Ethernet-based Network Controllers as described in Part 2 of the specification. These controllers will connect directly to the web server over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted.
 5. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).
- C. The Local Area Network (LAN) shall be either a 10 or 100 Mbps Ethernet network supporting BACnet, Modbus, XML and HTTPS for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Controllers (NCs), user workstations and a local host computer system.
- D. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.
- E. The system shall enable an architecture that utilizes BACnet IP as a common communication protocol between controllers and integral ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.
- F. The software tools required for network management of the BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner. BACnet clients shall comply with the BACnet Operator Workstation (B-OWS) device profile; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP.
- G. The system shall provide support for LONtalk, BACnet MSTP, Modbus TCP and RTU protocols natively, and not require the use of gateways.
- H. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, and power metering should easily coexist on the same network channel.
1. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs. The system shall not require JAVA to be enabled in the browser.
 2. Data shall reside on Network Controllers and existing web servers for all database access.
 3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.

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- I. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of 10 years of installation experience with the manufacturer and shall provide documentation in the submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the approved manufacturer's local field office.
- J. Provide the Commissioning, configuration and diagnostic tool (CCDT), color display personnel computer, software, and interfaces to provide uploading/downloading of High Point Count Controllers (AAC), Unitary Equipment Controllers (UEC) and VAV controllers (VAVDDC), monitoring all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of controller resident time schedules.

1.5 SUBMITTALS

- A. General: Submittals shall be in accordance with the requirements of Section 01 33 00 Submittals and Section 23 00 10 Mechanical, in addition to those specified herein.
 - 1. All shop drawings shall be prepared in Visio Professional or AutoCAD software, and provided on 11x17 prints.
 - 2. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical will be allowed where appropriate.
 - 3. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and air flow station schedules shall indicate size, configuration, capacity and location of all equipment.
 - 4. Submittals shall contain narrative descriptions of sequences of operation, wiring diagrams, controller layout, and point lists. Information shall be organized with an index and tabs. Diagrams shall be on 11" by 17". If color has been used to differentiate information, the printed copies shall be in color.
 - 5. Submit a hard copy (or digital copy, when approved) of the submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor, prior to submitting, shall check all documents for accuracy.
 - 6. The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved, or approved as noted.
 - 7. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as "As-Built".
 - a. System architecture drawing.
 - b. Layout drawing for each control panel
 - c. Wiring diagram for individual components
 - d. System flow diagram for each controlled system
 - e. Instrumentation list for each controlled system
 - f. Sequence of control
 - g. A matrix sheet detailing all system addresses and communication settings for the following:
 - 1) All IP network addresses & settings
 - 2) All BMS device addresses & communication settings
 - h. Operation and Maintenance Manuals

1.6 QUALITY ASSURANCE

- A. BMS Contractor shall have a full service facility that is staffed with engineers trained and certified by the manufacturer in the configuration, programming and service of the automation system. The contractor's technicians shall be fully capable of providing instructions and routine emergency maintenance service on

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all system components. All bidders must be authorized distributors or branch offices of the manufacturers specified.

- B. The BMS as specified herein shall be provided by Advanced Environment Solutions (AES).
 - 1. Advanced Environmental Solutions, Inc.
 - 2. Alternate: None
- C. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BMS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
- D. The BMS system supplier shall commission and set in operating condition all major equipment and systems, such as the hot water system, RTUs, exhaust systems, terminal units, and other equipment as specified in the sequences of operation.
- E. The BMS system supplier shall provide a technician and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building.
- F. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.
- G. Required elements of the startup testing include:
 - 1. Verification of proper controller power wiring.
 - 2. Verification of component inventory when compared to the submittals.
 - 3. Verification of labeling on components and wiring.
 - 4. Verification of connection integrity and quality (loose strands and tight connections).
 - 5. Verification of bus topology, grounding of shields and installation of termination devices.
 - 6. Verification of point checkout.
 - 7. Each I/O device is landed per the submittals and functions per the sequence of control.
 - 8. Analog sensors are properly scaled and a value is reported
 - 9. Binary sensors have the correct normal position and the state is correctly reported.
 - 10. Analog outputs have the correct normal position and move full stroke when so commanded.
 - 11. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
- H. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following.
 - 1. Graphics navigation.
 - 2. Trend data collection and presentation.
 - 3. Alarm handling, acknowledgement and routing.
 - 4. Time schedule editing.
 - 5. Application parameter adjustment.
 - 6. Manual control.
 - 7. Report execution.
 - 8. Automatic backups.
 - 9. Web Client access.

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1.7 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment from other divisions including "Motor Control Centers," "Panel boards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.
- C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.
- D. Coordinate with the Owner's IT department on locations for NC's, Ethernet communication cabling and TCP/IP addresses.

1.8 OWNERSHIP

- A. The Owner shall retain licenses to software for this project.
- B. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.
- C. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing or altering the system in the future. Use of the software by individuals under contract to the owner shall be restricted to use on the owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.
- D. All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:
 - 1. Server and workstation software
 - 2. Application programming tools
 - 3. Configuration tools
 - 4. Network diagnostic tools
 - 5. Addressing tools
 - 6. Application files
 - 7. Configuration files
 - 8. Graphic files
 - 9. Report files
 - 10. Graphic symbol libraries
 - 11. All documentation

1.9 WORK BY OTHERS

- A. The BMS system supplier shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
- B. The BMS system supplier shall furnish all Control Dampers, Control Valves, Flow Meters, Sensor Wells for installation by the Mechanical Contractor and/or others.
- C. Programming, setup, configuration, start-up, testing and commissioning of packaged control systems provided by the equipment manufacturer shall be furnished by the equipment manufacturer's technical representatives on site.
- D. The Electrical Contractor shall provide:

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- a. All 120VAC power wiring to motors, heat trace, junction boxes for power to BAS panels, as shown on the electrical drawings.
 - b. Furnish smoke detectors and wire to the building fire alarm system. Furnish fire alarm relay within 3' of BMS control panel for HVAC equipment required to be shut-down on an alarm. BMS contractor to wire from fire alarm relay into HVAC starter circuits.
 - E. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.
 - F. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.
 - G. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.
- 1.10 WARRANTY
- A. All components, system software, and parts furnished and installed by the BMS system supplier shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS system supplier at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS system supplier shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 standard working hours.
- 1.11 RECORD DOCUMENTATION
- A. Operation and Maintenance Manuals:
 - 1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:
 - a. Table of contents.
 - b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
 - c. Manufacturers' product data sheets or catalog pages for all products including software.
 - d. System Operator's manuals.
 - e. Archive copy of all site-specific databases and sequences.
 - f. BMS network diagrams.
 - g. Interfaces to all third-party products and work by other trades.
 - 2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following pre-qualified manufacturers, all provided by the BMS Contractor, Advanced Environmental Solutions. Contact Frank Miraglia 609-313-4745:

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1. Electric Components
 - a. ASI
 - b. Belimo
 - c. Siemens
2. Electronic Components
 - a. ASI
 - b. BAPI
 - c. Dwyer
 - d. Senva
 - e. Siemens
3. Direct Digital Control Systems Field Controller Devices:
 - a. KMC BACnet series controllers & Niagara N4 Web Supervisor Package

2.2 OPEN, INTEROPERABLE SYSTEM ARCHITECTURE

- A. A. General
 1. The Building Automation System (BAS) shall consist of Network Controllers (NCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.
 2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
 3. The Enterprise Level BAS shall support built-in reporting functionality without dependency on other software.
 4. The Enterprise Level BAS shall support standard accessing of data for third party reporting or analytics software.
 5. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.
 6. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP protocol.
- B. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, LonTalk FTT-10A, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported.
- C. A sub-network of SDCUs using the BACnet IP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.
- D. The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.
- E. The fieldbus layer shall support all of the following types of SDCUs:
 1. BACnet IP SDCU requirements: The system shall consist of one or more BACnet/IP field buses managed by the Network Server Controller. The field bus layer shall consist of up to 50 IP SDCUs in daisy chain topology, or 39 if using RSTP, per layer, with a max of 5 sub networks in daisy chain for a total of 250 SDCUs or 6 sub networks in RSTP for a total of 234 SDCUs.
 2. BACnet MSTP controllers may be used at the fieldbus layer. A maximum of 30 MSTP controllers per segment will be permitted.

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- F. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.
- G. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.
- H. System Expansion
 - 1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
 - 2. Web-based operation shall be supported directly by the NSCs and require no additional software.
 - 3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.
 - 4. The system shall be able to operate normally and without restriction at multiple software version levels with the only requirement that each element of the hierarchy be at least as new a version as the newest version in the level below it. In other words, Enterprise Servers will be able to manage NSCs of different version provided that the Enterprise Server was the same or more recent version than the most recent NSC version.
- I. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, LonWorks FTT-10, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.3 NETWORK CONTROLLERS (NC)

- A. General Requirements: The Network Controllers shall be Niagara N4 JACE-9000 controllers. The contractor shall expand the existing system to accomplish the following as part of this project.
 - 1. These controllers are designed to manage communications between the BACnet and/or LON field controllers, which are connected to its communications trunks or directly on the IP network, manage communications between itself, other system network controllers (NC), and with any Graphical User Interface (GUI) that are part of the BMS, and perform control and operating strategies for the system based on information from any controller connected to the BMS.
 - 2. The controllers shall be fully programmable or configurable to meet the unique requirements of the facility it shall control.
 - 3. The controllers shall be capable of peer-to-peer communications with other NC's, BACnet IP devices and with any OWS connected to the BMS, whether the OWS is directly connected, connected via cellular modem or connected via the Internet.
 - 4. The communication protocols utilized for peer-to-peer communications between NC's will be Niagara 4 FoxS, BACnet TCP/IP and SNMP. Use of a proprietary communication protocol for peer-to-peer communications between NC's is not allowed.
 - 5. All NC hardware licenses and certificates shall be stored on local MicroSD memory card employing encrypted "safe boot" technology.
 - 6. The NC shall employ a device count capacity license model that supports expansion capabilities.
 - 7. The NC shall utilize I/O Expansion Modules (IO-R-16 and/or IO-R-34) for direct control of equipment.
 - 8. The NC shall be enabled to support and shall be licensed with the following Open protocol drivers (client and server) by default:
 - a. BACnet

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- b. Lon
 - c. MODBUS
 - d. SNMP
 - e. KNX
9. The NC shall be capable of executing application control programs to provide:
- a. Calendar functions.
 - b. Scheduling.
 - c. Trending.
 - d. Alarm monitoring and routing.
 - e. Time synchronization.
 - f. Integration of LonWorks, BACnet, and MODBUS controller data.
 - g. Network management functions for all NC, and IP protocol connected devices.
10. The NC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
11. The NC shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment controllers.
12. The NC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via cellular modem, or wide-area network.
- a. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
 - 1) Alarm.
 - 2) Return to normal.
 - 3) To default.
 - b. Alarms shall be annunciated in any of the following manners as defined by the user:
 - 1) Screen message text.
 - 2) Email of complete alarm message to multiple recipients.
 - 3) Pagers via paging services that initiate a page on receipt of email message.
 - 4) Graphics with flashing alarm object(s).
 - c. The following shall be recorded by the SNC for each alarm (at a minimum):
 - 1) Time and date.
 - 2) Equipment (air handler #, access way, etc.).
 - 3) Acknowledge time, date, and user who issued acknowledgement.
13. Programming software and all controller "Setup Wizards" shall be embedded into the SNC.
14. The NC shall support the following security functions.
- a. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
 - b. Role-Based Access Control (RBAC) for managing user roles and permissions.
 - c. Require users to use strong credentials.
 - d. Data in Motion and Sensitive Data at Rest be encrypted.
 - e. LDAP and Kerberos integration of access management.
15. The NC shall support the following data modeling structures to utilize Search; Hierarchy; Template; and Permission functionality:
- a. Metadata: Descriptive tags to define the structure of properties.
 - b. Tagging: Process to apply metadata to components

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- c. Tag Dictionary
- 16. The NC shall employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms... that are set to be deployed as a unit based upon manufacturer's controller and relationships. All lower level communicating controllers shall have an associated template file for reuse on future project additions.
- 17. New NCs installed on this project shall be provided with a 5-Year Software Maintenance agreement.
- 18. Niagara N4 Data Collection and Storage:
 - a. The network controller shall collect data for any property of any object and store this data for future use.
 - 1) The data collection shall be performed by log objects, resident in the network controller that shall have, at a minimum, the following configurable properties: Designating the log as interval or deviation.
 - 2) For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - 3) For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - 4) For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - 5) Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
 - b. All log data shall be stored in a relational database in the network controller and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
 - c. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
 - d. All log data shall be available to the user in the following data formats:
 - 1) HTML
 - 2) XML
 - 3) Plain text
 - 4) Comma or tab separated values
 - e. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
 - f. The network controller shall have the ability to archive its log data either locally (to itself), or remotely to a server or other network controller on the network. Provide the ability to configure the following archiving properties, at a minimum:
 - 1) Archive on time of day
 - 2) Archive on user-defined number of data stores in the log (buffer size)
 - 3) Archive when log has reached its user-defined capacity of data stores
 - 4) Provide ability to clear logs once archived
- 19. Audit Log
 - a. Provide and maintain an Audit Log that tracks all activities performed on the network controller. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the network controller), to another network controller on the network, or to a server. For each log entry, provide the following data:
 - 1) Time and date
 - 2) User ID
 - 3) Change or activity (change set point, add or delete objects, commands, etc.)
- 20. Database Backup and Storage

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- a. The network controller shall have the ability to automatically back up its database. The database shall be backed up based on a user-defined time interval.
 - b. Copies of the current database and, at the most recently saved database shall be stored in the network controller. The age of the most recently saved database is dependent on the user-defined database save interval.
 - c. The network controller's database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.
 - d. Provisioning - Automatic downloading of software updates, backups to the entire system database etc. based on user defined parameters.
21. Graphical User Interface Software – Niagara N4 Supervisor®
- a. Existing system software and N4 Supervisor shall be expanded to include all mechanical and electrical system for this project as specified. This shall include modification to graphics, schedules, alarming and trends. Specific software requirements and features specified herein are for reference purposes.
 - b. The system software shall be based on server/thin-client architecture, designed around the open standards of web technology. The BMS server shall communicate using Ethernet and TCP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.
 - c. The intent of the thin-client architecture is to provide the operator(s) complete access to the BMS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Windows operating systems.
 - d. The BMS server software shall support at least the following server platforms (Windows 7, 8.1, 10, Server 12). The BMS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.
 - e. The web browser GUI shall provide a completely interactive user interface and shall provide a HTML5 experience that supports the following features as a minimum:
 - 1) Trending.
 - 2) Scheduling.
 - 3) Electrical demand limiting.
 - 4) Duty Cycling.
 - 5) Downloading Memory to field devices.
 - 6) Real time 'live' Graphic Programs.
 - 7) Tree Navigation.
 - 8) Parameter change of properties.
 - 9) Set point adjustments.
 - 10) Alarm / event information.
 - 11) Configuration of operators.
 - 12) Execution of global commands.
 - 13) Add, delete, and modify graphics and displayed data.
 - f. Software Components: All software shall be the most current version. All software components of the BMS system software shall be provided and installed as part of this project. BMS software components shall include:
 - 1) Server Software, Database and Web Browser Graphical User Interface.
 - 2) Embedded System Configuration Utilities for future modifications to the system and controllers.
 - 3) Embedded Graphical Programming Tools.
 - 4) Embedded Direct Digital Control software.

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- 5) Embedded Application Software.
- g. BMS Server Database: The BMS server software shall utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2. BMS systems written to Non -Standard and/or Proprietary databases are NOT acceptable.
- h. Thin Client - Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:
 - 1) Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet.
 - 2) Secure Socket Layers: Communication between the Web Browser GUI and IAS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol Secure (HTTPS).
- i. The following supervisory control applications shall be addressed as a minimum:
 - 1) Fire Alarm System response. (Secondary notification)
 - 2) Smoke Control system response. (Secondary notification)
 - 3) HVAC Global Sequence of Operation.
 - 4) Electrical Demand Limiting.
 - 5) Security System Message Priority Management.

2.4 BACNET IP FIELDBUS CONTROLLERS

A. Controllers – BACnet/IP Protocol

- 1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC)
- 2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
 - a. All controllers shall be able to communicate peer-to-peer without the need for a NC
 - b. Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:

- 1. Supporting IPv4 addressing
- 2. Supporting Static IP setting, DHCP client and Auto-IP address acquisition
- 3. It shall be possible to disable Ethernet port 2

C. Topologies

- 1. BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
- 2. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
 - a. In case of any disruption there shall be no communication interruption
 - b. In case of any disruption there shall be system alarms that will inform the operator of the disruption

D. Performance

- 1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.

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2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.
- E. Programmability
1. The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NC.
 2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs
 3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
 4. BACnet/IP Fieldbus controllers shall communicate with the Network Controller (NC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps
 5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.
 6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs
 7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding of output)
 8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
 - a. Control processes
 - b. Energy management applications
 - c. Alarm management
 - d. Historical/trend data
 - e. Maintenance support applications
 - f. Custom processes
 - g. Manual override monitoring
 9. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in I/O and at a minimum be capable of holding 5 days @ 15 min intervals locally.
 10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16 bit A/D converter.
 11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10 bit D/A converter.
 12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
 - a. At minimum 8 and up to 20 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
 - 1) Universal Inputs – the following thermistors for use in the system without any external converters needed.
 - a) 10 kohm Type I (Continuum)
 - b) 10 kohm Type II (I/NET)
 - c) 10 kohm Type III (Satchwell)
 - d) 10 kohm Type IV (FD)
 - e) Linearized 10 kohm Type V (FD w/11k shunt)
 - f) Linearized 10 kohm (Satchwell)
 - g) 1.8 kohm (Xenta)
 - h) 1 kohm (Balco)
 - i) 20 kohm (Honeywell)
 - j) 2.2 kohm (Johnson)
 - k) PT100 (Siemens)
 - l) PT1000 (Sauter)
 - m) Ni1000 (Danfoss)
 - 2) Analog inputs
 - a) Current Input - 0-20 mA
 - b) Voltage Input 0-10 Vdc
 - 3) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - 4) Digital outputs

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- 5) Analog outputs of 4-20 mA and/or 0-10 Vdc
- 13. Real Time Clock (RTC):
 - a. Provide internal clocks for all BACnet Controllers (B-AAC) using BACnet time synchronization services.
 - 1) Automatically synchronize system clocks daily from an operator-designated controller.
 - 2) The system shall automatically adjust for daylight saving time.
 - b. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month.
 - c. The RTC shall provide the following: time of day, day, month, year, and day of week.
 - d. The RTC date and time shall also be accurate up to 7 days, from when the BACnet/IP Fieldbus controller has lost power with no reliance on.
- 14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications
 - a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in 'flow thru' differential pressure transducer
 - b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of $\pm 5\%$ at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., insuring primary air flow conditions shall be controlled and maintained to within $\pm 5\%$ of setpoint at the specified minimum and maximum air flow parameters
 - c. The BACnet/IP Fieldbus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing
 - d. The BACnet/IP Fieldbus controller for VAV applications shall require no programming for air balancing algorithm
- 15. Power Requirements. 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power
- 16. Each BACnet/IP Fieldbus controller shall be accredited for smoke control and smoke management within a fully IP control solution
- 17. The BACnet/IP Fieldbus controller shall comply with the following regulatory certifications
 - a. CE - EMCD 2014/30/EU
 - b. CE LVD 2014/35/EU
 - c. FCC CFR 47 Part 15 Class B
 - d. RCM
 - e. RoHS 2011/65/EU
 - f. China RoHS SJ/T 11364-2014
 - g. UL2043 (Plenum space mounting)
 - h. UL916 Open-Energy Management equipment
 - i. UL916 Energy Management equipment
- 18. Intelligent Space Sensor Interface –
 - a. The BACnet/IP Fieldbus controllers shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on-board inputs or outputs
 - b. It shall be possible to disable the RJ45 communication port.
- F. Commissioning Tool - The BACnet/IP Fieldbus controllers shall be supported via a dedicate mobile based commissioning tool for configuration, programming, air balancing and I/O checkout:
 - 1. The Commissioning Tool shall be supported across: iOS, Android and Windows 10 platforms
 - 2. The Commissioning Tool shall be available for download on App Store, Google Store and Windows Store
 - 3. Commissioning Tool Interface to BACnet/IP Fieldbus controllers shall be via Bluetooth or via a Wi-Fi access point on the LAN

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4. Functionality
 - a. Device Configuration – the Commissioning Tool shall be able to set or edit all Network configurations associated with the BACnet/IP Fieldbus controller
 - b. Programming – The Commissioning Tool shall be able to load offline engineered applications directly in to the controller directly
 - c. Air Balancing
 - 1) The Commissioning Tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, and close all VAV dampers.
 - 2) The Commissioning Tool shall be able to generate Air Balancing report
 5. IO Checkout
 - a. The Commissioning Tool shall be able to support overriding of the outputs and reading value of inputs live that includes light and blind points and their configuration
 - b. The Commissioning Tool shall be able to support generation of I/O checkout report
 6. There shall be no limit to the number of Commissioning Tools that can be used on a network segment.
- G. Intelligent Space Sensors - The BACnet/IP Fieldbus controller shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on board inputs or outputs
1. The Intelligent Space Sensor shall communicate with the BACnet/IP Fieldbus controller through the sensor port and via category 5 or category 6 cable
 2. The Intelligent Space Sensor shall provide 2 RJ45 communication ports that will allow communication with parent BACnet/IP Field controller upstream and additional Intelligent Space Sensors downstream
 3. The Intelligent Space Sensor shall provide ambient space condition sensing without the use of hardware I/O
- H. Each Intelligent Space Sensor shall provide a color touch display with:
1. Minimum 48 mm by 32 mm display
 2. Backlit
- I. The Intelligent Space Sensor shall be capable of displaying measured space temperature from 0 to 50 °C (32 to 122 °F) with accuracy of ± 0.2 °C (± 0.4 °F) selectable for 0.1 or 1 degree display resolution of °F or °C
1. Sensing Element: 10k Type 2 Thermistor
 2. Accuracy of ± 0.2 °C (± 0.4 °F)
 3. Resolution: 0.1 or 1 degree display resolution
 4. Range: 0 to 50 °C (36 to 120 °F)
- J. The Intelligent Space Sensor shall have the option for humidity sensor support sensing humidity from 0 % RH to 100 % RH Digital humidity indication (selectable for 0.1 or 1% RH with selectable display resolution of 0.1 or 1 % RH
1. Accuracy: ± 2 % RH
 2. Resolution: 0.1 or 1 % RH
 3. Range: 0 % RH to 100 % RH
- K. The Intelligent Space Sensor shall have the option for support of CO2 sensor with display resolution with 0 to 2000 ppm resolution
1. Accuracy: ± 50 ppm $\pm 3\%$ of measured value
 2. Range: 0 to 2,000 ppm
 3. Operating elevation: 0 to 16,000 ft.
 4. Temperature dependence: 0.11% FS per °F
 5. Stability: <2% of FS over life of sensor (15 years)

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6. Sensing method: Non-dispersive infrared (NDIR), diffusion sampling
- L. The Intelligent Space Sensor shall have the option for motion sensor
- M. Display options: The Intelligent Space Sensor shall be capable of displaying the following elements:
 1. Space temperature
 2. Cooling space temperature set point
 3. Heating space temperature set point
 4. Current heating or cooling mode
 5. Current occupancy mode
 6. Fan speed
 7. Current time
 8. Light control
 9. Blind adjustment
 10. Scene selection

2.5 BACNET FIELDBUS AND BACNET SDCUS

- A. Networking
 1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
 2. IP To Field Bus Routing Devices
 - a. A Network Server Controller shall be used to provide this functionality.
 - b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
 - c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.
- B. Field Bus Wiring and Termination
 1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
 2. Each field bus shall have a termination resistor at both ends of each segment.
- C. Repeaters
 1. Repeaters are required to connect two segments.
 2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.
- D. Field Bus Devices
 1. General Requirements
 - a. Devices shall have a light indicating that they are powered.
 - b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
 - c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)
- E. Advance Application Controllers (B-AAC)
 1. The key characteristics of a B-AAC are:
 - a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.

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- b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
 - c. The application to be executed by a B-AAC is created by an application engineer using the vendor's application programming tool.
 - d. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
 - e. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
 - f. If local alarm message initiation is embedded, the B-AAC shall:
 - 1) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the alarm message.
 - 2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,
 - g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
 - h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
 - i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
 - j. Shall support the "Who is" and "I am." BACnet services.
 - k. Shall support the "Who has" and "I have." BACnet services.
2. Analog Input Circuits
- a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
 - b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
 - c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
 - d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.
3. Binary Input Circuits
- a. Dry contact sensors shall wire to the controller with two wires.
 - b. An external power supply in the sensor circuit shall not be required.
4. Pulse Input Circuits
- a. Pulse input sensors shall wire to the controller with two wires.
 - b. An external power supply in the sensor circuit shall not be required.
 - c. The pulse input circuit shall be able to process up to 20 pulses per second.
5. True Analog Output Circuits
- a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
 - b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
6. Binary Output Circuits
- a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.

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- b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.
 - 7. Program Execution
 - a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
 - b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
 - c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
 - d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
 - e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.
 - 8. Local Interface
 - a. The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
 - 1) Adjust application parameters.
 - 2) Execute manual control of input and output points.
 - 3) View dynamic data.
 - F. Application Specific Devices
 - 1. Application specific devices shall have fixed function configurable applications.
 - 2. If the application can be altered by the vendor's application programmable tool, the device is an advanced application controller and not an application specific device.
 - 3. Application specific devices shall be BTL certified.
- 2.6 DDC SENSORS AND POINT HARDWARE
- A. Temperature Sensors
 - 1. Acceptable Manufacturers: Veris Industries, ASI, BAPI, KMC
 - 2. Compatible with applicable DDC Controller.
 - B. Humidity Wall Transmitter
 - 1. Acceptable Manufacturer: Veris Industries, ASI, BAPI, KMC
 - 2. Transmitters shall be accurate to +/- 2 % at full scale.
 - 3. Transmitter shall have replaceable sensing element.
 - 4. Sensor type shall be thin-film capacitive.
 - 5. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
 - 6. Operating range shall be 0 - 100% RH noncondensing, 50 to 95 F
 - 7. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC.
 - 8. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
 - 9. Transmitter shall be available in an off white enclosure made of high impact ABS plastic for mounting on a standard electrical box.
 - 10. Transmitter shall have option of having an LCD display
 - 11. Transmitter shall have option of being NIST certified
 - 12. Transmitter shall have option of an integrated temperature sensor
 - C. Humidity Duct Transmitter
 - 1. Acceptable Manufacturer: Veris Industries, Dwyer, BAPI, KMC
 - 2. Transmitters shall be accurate to +/- 2 % at full scale.

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3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe.
 4. Transmitter shall have replaceable sensing element.
 5. Sensor type shall be thin-film capacitive.
 6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
 7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
 8. Output shall be 4-20 mA or 0-5/0-10 VDC.
 9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
 10. Transmitter shall have option of being NIST certified
 11. Transmitter shall have option of an integrated temperature sensor
- D. Humidity Outdoor Transmitter
1. Acceptable Manufacturer: Veris Industries, BAPI, KMC
 2. Transmitters shall be accurate to +/- 2% at full scale.
 3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
 4. Transmitter shall have replaceable sensing element.
 5. Sensor type shall be thin-film capacitive.
 6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
 7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
 8. Output shall be 4-20 mA or 0-5/0-10 VDC.
 9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
 10. Transmitter shall have option of being NIST certified
 11. Transmitter shall have option of an integrated temperature sensor
- E. Carbon Dioxide Wall Transmitter:
1. Acceptable Manufacturer: Veris Industries, SenseAir, KMC
 2. Sensor type shall be Non-dispersive infrared (NDIR).
 3. Accuracy shall be ± 30 ppm $\pm 2\%$ of measured value.
 4. Repeatability shall be ± 20 ppm $\pm 1\%$ of measured value
 5. Response Time shall be <60 seconds for 90% step change
 6. Outputs shall be field selectable [Analog: 4-20mA or 0-5/0-10VDC]
 7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
 8. Temperature Range: [32° to 122°F]
 9. Output range shall be programmable 0-2000 or 0-5000 ppm
 10. Transmitter shall be available in an off white enclosure for mounting on a standard electrical box.
 11. Transmitter shall have an option of an LCD display for commissioning and provide additional faceplate to conceal LCD display where occupants may misinterpret CO2 readings.
 12. Transmitter shall have option of an integrated temperature sensor and/or humidity sensor
 13. Transmitter shall have the option of an integrated temperature and/or humidity sensor.
- F. Current Sensors
1. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in split core models, and offer either a digital or an analog signal to the automation system.
- G. Current Status Switches for Constant Load Devices
1. Acceptable Manufacturer: Veris Industries, Functional Devices, Senva
 2. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on constant loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
 3. Visual LED indicator for status.

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4. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 0.5 A to 175 A.
 5. Normally open current sensor output. 0.1A at 30 VAC/DC.
 6. Basis of Design: Veris Model H608.
- H. Current Status Switches for Variable Frequency Drive Application
1. Acceptable Manufacturer: Veris Industries, Functional Devices, Senva.
 2. General: Microprocessor controlled, self-learning, self-calibrating current sensor to detect motor undercurrent and overcurrent situations such as belt loss, coupling shear, and mechanical failure on variable loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory and relearn.
 3. Visual LED indicator for status.
 4. Alarm Limits: $\pm 20\%$ of learned current in every 5 Hz freq. band
 5. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 1.5 A to 150 A and from 12 to 115 Hz.
 6. Normally open current sensor output. 0.1A at 30 VAC/DC.
- I. Flow Meters:
1. Acceptable Manufacturer: Veris Industries, Dwyer, Data Industrial
- J. Airflow Monitoring Stations:
1. Acceptable Manufacturer: TrueFIT, Ebtron
 2. Permanently mounted Airflow Measurement System (AFMS) for installation on terminal units, packaged equipment, built-up air handlers, outdoor air intakes, and airflow tracking applications. The AFMS shall be operated on a local device (such as a BACnet® Advanced Application Controller [AAC]) capable of measuring the following properties via the Characterized Airflow Performance method:
 - a. Outside Airflow & Temperature
 - b. Return Airflow & Temperature
 - c. Supply Airflow & Mixed Air Temperature
 3. Airflow measurement device shall determine airflow using the Characterized Airflow Performance method based on ASHRAE standards 111 and 189.1.
 4. Airflow measurement device shall measure airflow by independently measuring outside air intake or return air damper position and [fans/fan arrays airflow rate] or [duct airflow rate], applying the Characterized Airflow method.
 5. Outside Air Intake: Provide damper position sensor to comply with ASHRAE standards 111 and 189.1. Sensor shall account for hysteresis in linkages and damper blade deterioration.
 6. Fan/Fan Array: Each fan shall include a differential pressure flow sensor with multiple total and static pressure measuring ports installed across the fan inlet or a factory installed piezometer ring airflow station.
 7. Duct Airflow: Where flow measurement at the Fan/Fan Array is not possible or flow measurement in the duct is preferred, each system shall include a differential pressure flow sensor with multiple total and static pressure measuring ports that complies with ASHRAE standard 111 for duct traversing.
 8. Measurement system accuracy shall be $\pm 3\%$ of volumetric airflow rate or better with factory recommended sensor installation locations. Factory recommends that a certified representative verify that sensors are installed as specified. Field accuracy may be validated by a certified factory representative or certified balancing technician.
- K. Water Control Valves
1. Acceptable Manufacturers: Schneider Electric, Belimo
 2. Ball valves with characterizing disc.
 3. Chrome-plated brass ball, nickel plated brass stem & forged brass nickel plated body.
- L. Damper Actuators

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1. Acceptable Manufacturers: Schneider Electric, Belimo
2. Direct-coupled type non-hydraulic designed for minimum 100,000 full-stroke cycles at rated torque.
3. Direct-coupled damper actuators must have a five-year warrantee.
4. Size for torque required for damper seal at maximum design conditions and valve close-off pressure for system design.
5. Direct-coupled damper actuators should accommodate 3/8", 1/2" 1.05" round or 3/8"...1/2" and 3/4" square damper shafts.
6. Actuator operating temperature minimum requirements: 44, 88 and 133 lb.-in. are -25°F...130°F (-32°C...55°C). The 30, 35, 60, 150 and 300 lb.-in. are -25°F...140°F (-30°C... 60 °C). The 270 are -22°F...122°F (-30°C... 50 °C).
7. Overload protected electronically throughout rotation except for selected Floating actuators the have a mechanical clutch.
8. Spring Return Actuators: Mechanical fail safe shall incorporate a spring-return mechanism.
9. Non-Spring Return Actuators shall stay in the position last commanded by the controller with an external manual gear release to allow positioning when not powered.
10. Power Requirements: 24Vac/dc [120Vac][230Vac]
11. Proportional Actuators controller input range from 0...10 Vdc, 2...10 Vdc or 4...20 mA models.
12. Housing: Minimum requirement NEMA type 1 with NEMA type 4 available for applications requiring higher ratings.
13. Actuators with a microprocessor should not be able to be modified by an outside source (cracked or hacked).
14. Actuators of 133 and 270 lb.-in. of torque or more should be able to be tandem mount or "gang" mount.
15. Agency Listings: ISO 9001, cULus, CE and CSA
16. Basis of Design: Schneider Electric SmartX Actuators, or approved equal.

2.7 PROGRAMMING

- A. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25% of available memory free for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- C. Software Programming: Provide programming for the system as per specifications and adhere to the strategy algorithms provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the BAS vendor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.
- D. Operators' Interface: The controls manufacturer shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data base, and any 3rd party software installation and integration required for successful operation of the operator interface.

2.8 CLEANING

- A. The Contractor shall clean up all debris resulting from his or her activities daily. The Contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the General Contractor.
- B. At the completion of work in any area, the Contractor shall clean all his/her work, equipment, etc., making it free from dust, dirt, and debris, etc.

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PART 3 - EXECUTION

3.1 GENERAL

- A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Section 23 00 00 and Drawings.
- B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.
- C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- D. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.
- E. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.
- F. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.
- G. Access to Site
 - 1. Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's Representative.
- H. Code Compliance
 - 1. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations.
- I. Cleanup
 - 1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

3.2 SYSTEM ACCEPTANCE TESTING

- A. All application software will be verified and compared against the sequences of operation.
- B. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.
- C. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.
- D. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.
- E. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

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3.3 INSTALLATION

A. Hardware Installation Practices for Wiring

1. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
2. The 120VAC power wiring to each control panel shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device. 120VAC power to panel (including conduit, wire & circuit breaker) shall be by the Electrical Contractor.
3. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
4. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.
5. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls.
6. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
7. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.
8. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
9. Wire will not be allowed to run across telephone equipment areas.
10. Provide fire caulking at all rated penetrations.

B. Installation Practices for Field Devices

1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
3. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
5. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
6. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building.

C. Wiring, Conduit, and Cable

1. All wire will be copper and meet the minimum wire size and insulation class listed below:
 - a. Power - 12 Gauge - 600 Volt
 - b. Class One - 14 Gauge Std. - 600 Volt
 - c. Class Two - 18 Gauge Std. - 300 Volt
 - d. Class Three - 18 Gauge Std. - 300 Volt
 - e. Communications - Per Mfr.
2. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.
3. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
4. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 3/4 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

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5. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
6. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
7. Low-voltage cabling in mechanical rooms, electrical rooms or where subject to damage shall be installed in conduit. Low voltage cabling installed above accessible ceiling shall be plenum rated, and professionally fastened to building structure utilizing J-Hooks. Wall-mount thermostats, sensors and devices shall be mounted in single-gang box with conduit and turn-out to accessible ceiling above, where possible.
8. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.
9. Only glass fiber is acceptable, no plastic.
10. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS system supplier shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

D. Enclosures

1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
3. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated.
4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
5. All outside mounted enclosures shall meet the NEMA-4 rating.
6. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

E. Identification

1. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
2. All field enclosures, other than controllers, shall be identified with a Bakelite nameplate. The lettering shall be in white against a black or blue background.
3. All I/O field devices inside FIP's shall be labeled.

F. Location

1. The location of sensors is per mechanical and architectural drawings.
2. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.
3. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.
4. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

G. Software Installation

1. The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

3.4 TRAINING

- A. The BAS system supplier shall provide training for the controls installed as part of this project.

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- B. On-site training shall consist of a minimum of (8) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include
 - 1. System Overview
 - 2. System Software and Operation
 - 3. System access
 - 4. Software features overview
 - 5. Changing setpoints and other attributes
 - 6. Scheduling
 - 7. Editing programmed variables
 - 8. Displaying color graphics
 - 9. Running reports
 - 10. Workstation maintenance
 - 11. Viewing application programming
 - 12. Operational sequences including start-up, shutdown, adjusting and balancing.
 - 13. Equipment maintenance

3.5 DATABASE CONFIGURATION.

- A. The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

3.6 COLOR GRAPHIC DISPLAYS.

- A. Unless otherwise directed by the owner, the Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

3.7 REPORTS.

- A. The Contractor will configure a minimum of 4 reports for the owner. These reports shall, at a minimum, be able to provide:
 - 1. Trend comparison data
 - 2. Alarm status and prevalence information
 - 3. Energy Consumption data
 - 4. System user data

3.8 POINT TO POINT CHECKOUT.

- A. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.
- B. In case of wireless devices, the signal strength recorded during checkout shall be reported.

3.9 CONTROLLER AND WORKSTATION CHECKOUT.

- A. A field checkout of all controllers and front end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.

3.10 DOCUMENTATION

- A. As built software documentation will include the following:
 - 1. Descriptive point lists

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2. Application program listing
3. Application programs with comments.
4. Printouts of all reports.
5. Alarm list.
6. Printouts of all graphics
7. Commissioning and System Startup
8. An electronic copy of all databases, configuration files, or any type of files created specifically for each system.

PART 4 - SEQUENCE OF OPERATIONS

4.1 GENERAL

- A. The Building Management System (BMS) shall be programmed in accordance with the mechanical drawings and as specified herein.

4.2 HOT WATER HEATING SYSTEM

- A. Each hot water system consists of two (2) boilers with in-line pumps, and two (2) hot water system pumps with VFD's.
- B. The hot water system will be enabled whenever any equipment is calling for hot water.
- C. The boilers will be furnished with a factory control system that once enabled will stage and modulate the boilers to maintain the hot water supply temperature setpoint.
- D. The building automation system will have the ability to read/write to any boiler system points that are made available by the boiler manufacturer through a BACnet interface.
- E. The integral boiler controls start the appropriate in-line pump for each boiler.
- F. Emergency shut-off switches at each entrance shall shut down the boilers and pumps.
- G. When the hot water system is enabled the lead hot water pump will be enabled and its speed will be modulated as described below. Once the pump is operating as sensed by a current switch the BMS will enable the factory boiler control system through a digital output.
- H. The lead pump VFD will be modulated to maintain the hot water system differential setpoint.
- I. With the lead pump running at full speed for an adjustable time period, the lag pump shall energize and each pump shall run at equal speeds to maintain differential pressure.
- J. With decreasing load and with both pumps running at 40% for an adjustable time period, the lag pump shall de-energize and the lead pump VFD shall modulate to maintain system pressure.
- K. In the event of a pump failure, the pump will be disabled and the next pump in the rotation will be enabled.
- L. The lead pump will be rotated to equalize runtimes.
- M. Points - The following represents the minimum list of points to be displayed on the graphics. Provide override capability for all outputs. Beyond what is listed below provide additional trending and alarms in accordance with the existing district standard:
 1. Analog Inputs:
 - a. Hot Water Supply Temperature
 - b. Hot Water Return Temperature

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- c. Hot Water System Differential Pressure
- 2. Digital Inputs:
 - a. Boiler Alarm (per Boiler)
 - b. Boiler Status (per Boiler)
 - c. Boiler Pump Status (per pump)
 - d. System Pump Status (per pump)
 - e. Emergency Shut-Down Status
- 3. Analog Outputs:
 - a. Boiler System Setpoint Reset
 - b. System HW Pump #1 Speed Control
 - c. System HW Pump #2 Speed Control
- 4. Digital Outputs:
 - a. Boiler System Enable
 - b. System HW Pump #1 Start
 - c. System HW Pump #2 Start
- 5. Alarms:
 - a. Boiler Failure (each boiler)
 - b. Hot Water Pump Failure (each pump)
 - c. Hot Water Pump Running in Hand (each pump)
 - d. Hot Water Pump VFD Fault (each pump)
 - e. High Hot Water Pump Differential Pressure
 - f. High Hot Water Supply Temperature
 - g. Low Hot Water Pump Differential Pressure
 - h. Low Hot Water Supply Temperature

4.3 SINGLE ZONE RTAH UNITS WITH FREE COOLING, ERV WHEEL, AND DEMAND VENTILATION (RTAH-04 and 05)

- A. General: Single-zone VAV RTUs consist of a supply fan w/VFD, exhaust fan w/VFD, energy wheel w/VFD, chilled water cooling, and a hot water reheat coil. The unit is indexed to Occupied or Unoccupied mode via the schedule defined in the BAS. The RTU control utilizes a constant temperature, variable flow strategy, with the discharge air temperature reset by space conditions.
- B. Safeties: A manual reset low limit thermostat stops the supply & exhaust fans, stops the energy wheel, closes the outside air damper & exhaust damper, and opens the spring-return hot water valve. Duct smoke detectors (where applicable) also shut down the unit and close the outside air damper. The low limit and smoke detector alarm are annunciated separately to the BAS.
- C. Preoccupancy Modes: DDC controller shall employ optimal start to energize the unit in either warm-up or cool-down mode, in order to bring the space to occupied setpoint by the occupied start time.
 - 1. Warm-up:
 - a. Supply fan shall start and run at 100%.
 - b. Exhaust fan and energy wheel shall be OFF
 - c. Outside air damper closed, return air damper open.
 - d. Chilled water valve closed.
 - e. Hot water valve shall modulate to maintain discharge air temperature of 100F.
 - 2. Cool Down:
 - a. Supply fan shall start and run at 100%.
 - b. Exhaust fan and energy wheel shall be OFF.
 - c. Outside air damper closed, return air damper open.
 - d. Hot water valve closed.
 - e. Chilled water valve shall modulate to maintain discharge air temperature of 55F.
- D. Occupied Mode:
 - 1. The Supply fan is energized and will initially operate at minimum speed (66.7% of design airflow).
 - 2. Outside air damper opens to minimum position with return air damper closing proportionally.
 - 3. Energy wheel shall be ON, and bypass dampers set to flow through the wheel (unless in economizer mode).
 - 4. The hot water valve and chilled water valves shall control to maintain discharge air temperature as follows:

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% Heating Demand	Discharge Air Temp Setpoint
0%	70F
80%	95F

% Cooling Demand	Discharge Air Temp Setpoint
0%	70F
30%	55F

5. Supply Fan Speed Control: As the heating demand rises above 80%, or the cooling demand rises above 30%, the supply fan shall linearly increase in speed to 100% of design airflow.
6. Exhaust Fan Speed Control: Exhaust fan shall modulate to maintain space pressure setpoint.
7. Economizer Control: Energy wheel shall be de-energized and the bypass dampers set to bypass the wheel during economizer. Outside air/return air dampers shall be enabled to modulate for free cooling under the following conditions:
 - a. Outside air temperature is < 65F.
 - b. Outside air enthalpy is < 25 BTU/lb.
 - c. Outside air enthalpy is less than space enthalpy by more than 2 BTU/lb.
 - d. Supply fan is ON & cooling required.
8. Outside air damper shall modulate closed to over-ride economizer control, to maintain a minimum mixed air temperature of 48F. Mixed air low limit control shall over-ride CO2 and normal temperature control.
9. Dehumidification Control: If the space relative humidity rises above setpoint AND the space temperature is above 72F, AND the outside air temperature is greater than 60F, the unit shall enter DEHUM mode. In DEHUM mode, the chilled water valve shall modulate to maintain 55F and the reheat valve shall be modulated to maintain space temperature cooling setpoint.
10. Minimum OA Ventilation: Outside air damper shall modulate open to maintain a maximum CO2 level of 900 PPM. Mixed air dampers shall not open at a rate greater than 2% per minute.
11. Wheel VFD Control (Defrost): If the outside air temperature is less than 15F, AND the space relative humidity is above the defrost setpoint (50%), then the wheel shall cycle for defrost.

E. Unoccupied Mode:

1. During unoccupied mode, or any time the unit is NOT running (due to a supply fan failure or OFF over-ride, etc), the supply fan, exhaust fan, and wheel shall be OFF.
2. Outside air damper shall be closed, return air damper open, and hot water valve shall be positioned as follows:
 - a. OA Temp > 40F; Hot Water Valve is Closed.
 - b. OA Temp < 40F; Hot Water Valve Positioned to 50%; however, if discharge air temperature rises above 65F, the valve will modulate to maintain 60F discharge air temperature, down to an absolute minimum of 25% open.
 - c. OA Temp < 25F; Hot Water Valve Open
3. Unoccupied Heating/Cooling – If during the unoccupied mode, the space temperature rises above or falls below the space unoccupied heating/cooling temperature setpoints, the unit shall energize and operate as described in either Warm Up or Cool Down mode until the space temperature rises above/falls below the unoccupied setpoint, with a differential of 2F. Unit shall also energize and run in dehumidification mode if the space humidity rises above setpoint with space temperature above 72F as previously specified.

F. Points: The following represents the minimum list of points to be displayed on the graphics. Provide over-ride capability for all outputs. Trending and alarms to be provided in accordance with the existing district standard.

1. Analog Inputs:
 - a. Space Temperature & Setpoint
 - b. Space Humidity
 - c. Space CO2
 - d. Supply Air Temperature
 - e. Clg Coil Leaving Air Temperature
 - f. Mixed Air Temperature
 - g. Exhaust Air Temperature
 - h. Outside Air Temperature
 - i. Space Pressure
 - j. Supply Airflow
 - k. Exhaust Airflow

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- I. Outside Airflow
- 2. Digital Inputs:
 - a. Occupied Over-ride
 - b. Supply Fan Status
 - c. Exhaust Fan Status
 - d. Wheel Rotation Status
 - e. Filter Status
 - f. Low Limit Status
 - g. Smoke Detector Status
 - h. Condensate Overflow Alarm
- 3. Analog Outputs:
 - a. Supply Fan VFD Speed
 - b. Exhaust Fan VFD Speed
 - c. Chilled Water Valve Control
 - d. Hot Water Valve Control
 - e. Economizer Control
- 4. Digital Outputs:
 - a. Supply Fan Start/Stop
 - b. Exhaust Fan Start/Stop
 - c. Wheel Start/Stop
 - d. Wheel Bypass Dampers Open/Close

4.4 CONTROL OF EXHAUST FANS

- A. Timer Wall Switch: These fans shall run via a timer wall switch supplied and installed by the E.C.

4.5 CONTROL OF HOT WATER CABINET AND HORIZONTAL UNIT HEATERS

- A. Space thermostats shall open the hot water valve and energize the fan on a call for heat. Provide aquastats on unit heaters to prevent fan operation when hot water is not available.

4.6 CONTROL OF DUCTLESS SPLIT SYSTEM UNITS (AC/CU)

- A. General: AC units are provided with self-contained controls. BAS to monitor and alarm space temperature.

END OF SECTION 23 09 00

SECTION 23 09 90 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic systems.
- C. Measurement of final operating condition of HVAC systems.

1.2 REFERENCES

- A. AABC - National Standards for Total System Balance
- B. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems
- C. SMACNA - HVAC Systems Testing, Adjusting, and Balancing

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 23 00 10.
- B. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
- C. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- D. Provide reports in binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include sets of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.
- E. Test Reports: Indicate data on Standard AABC or NEBB Forms.

1.4 SEQUENCING

- A. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 AGENCIES

- A. Work shall be performed by HVAC Contractor who shall provide preliminary balancing.
- B. School District will contract separately with an independent air balancing firm to do final air and water balancing and preparation of reports.

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- C. HVAC Contractor shall coordinate with and cooperate with School District's designated air balancing firm.

3.2 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 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. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are 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 is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place.
 - 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance as soon as observed.
- C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations.
- B. Provide additional balancing devices as required.

3.4 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within $\pm 5\%$ of design for supply systems and $\pm 10\%$ of design for return and exhaust systems.
- B. Hydronic Systems: Adjust to within $\pm 10\%$ of design.

3.5 ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- E. Recheck points or areas as selected and witnessed by the Owner.

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3.6 AIR SYSTEM PROCEDURE (by Owner Contracted TAB Firm)

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross-sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. 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% loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions.

3.7 WATER SYSTEM PROCEDURE (by Owner Contracted TAB Firm)

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.8 COORDINATION WITH SCHOOL DISTRICT TAB AGENCY

- A. The Owner will contract separately the Air Balancing, Commissioning, and Inspection of the HVAC Equipment outside the scope of this contract. This work will be performed by an Independent Testing and Balancing Agency that is AABC or NEBB Certified.
- B. The HVAC Contractor shall coordinate the work of the contractors performing the HVAC, Electrical, Automatic Temperature Control, and Testing and Balancing work to provide complete properly tested and adjusted systems. The HVAC Contractor shall provide a start-up report for each piece of equipment that is installed on

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the project. The HVAC Contractor shall provide the Balancing Agency copies of the start-up reports for all of the HVAC equipment.

- C. The HVAC Contractor shall coordinate all mechanical work, including sheet metal and automatic temperature controls, to provide a complete, properly tested and adjusted system throughout. He shall furnish progress reports regarding this phase of the work on a regular basis as directed. At such time as the systems are started up, the contractor performing the mechanical work shall provide the Balancing Agency documentation that the duct systems have been tested to the satisfaction of the Duct Leak Test Specifications. The Mechanical Contractor shall insure that all components are installed and operating and that the major components such as fans, pumps, refrigeration machines and the like are capable of producing the schedule capacity requirements. This requirement does not relieve the Mechanical Contractor of any requirements specified elsewhere. Should any of these components or systems be found not capable of producing these requirements, he shall certify in writing that the systems are ready for final testing and balancing by the testing and balancing agency.
- D. The HVAC Contractor shall provide to the balancing agency any documentation and/or report for all systems that were required to have Factory Start-Up and/or System Commissioning performed.
- E. The HVAC Contractor, responsible for the piping of the Chilled and Hot Water Systems shall insure that the systems have the air removed from the system and that the Automatic Temperature Control Valves are in the open position to the coil when the system is filled. The Mechanical Contractor is responsible to fill the water system, set the automatic fill valve and report in writing to the balancing agency, the setting of the automatic fill valves.
- F. The contractor performing the electrical construction work shall coordinate all electric work to provide complete, properly tested and adjusted electrical systems throughout the complex. He shall furnish progress reports on a regular basis as directed. He shall certify in writing when each system is electrically operable, including the check for proper rotation of all HVAC equipment.
- G. The Electrical Contractor will support the balancing agency in obtaining any data that is required by the specifications to be taken on any existing HVAC System as required.
- H. The contractor performing the automatic temperature control work shall coordinate all Automatic Temperature Control (ATC) work to provide complete, properly tested and adjusted ATC Systems for every point throughout the facility. He shall furnish progress reports on a regular basis as directed. He shall certify in writing when each system control is operable, including the check and calibration of all control devices.
- I. The Testing and Air Balancing Agency (TAB Agency) will be responsible for the following:
 - 1. HVAC Inspections: The TAB Agency will provide 18 random inspections during the construction phase of this project. They will coordinate, witness, verify and report to the Owner on construction, progress, quality, start-up and operation of all mechanical HVAC equipment systems and subsystems. Ensure that the HVAC System and Building Management Systems and equipment are installed in accordance with contract documents, and that they operate as intended and specified by the Project Engineer. The TAB Agency will be present at the Owner's request at meetings where the mechanical and electrical systems are accessed and discussed by the project design team.
 - 2. Testing and Balancing: The TAB Agency will provide testing and balancing of the Air and Hydronic Systems related to the HVAC Systems for this project. The testing and balancing will be performed in accordance with the Project Specifications. Where items are not identified in the Project Specifications, AABC or NEBB procedural standards for testing, adjusting, and balancing will be followed.
 - 3. Building Systems Commissioning: The TAB Agency will provide random commissioning to ensure the building system is complete and in compliance with the plans and specifications. This includes, but is not limited to:
 - a. Verifying the operation of system components under various conditions.
 - b. Verifying interactions between systems and subsystems.
 - c. Documenting system performance in reference to design criteria.
 - 4. Under the agreement with the Owner, the TAB Agency will:
 - a. Check the operation of all major mechanical equipment, boilers, chiller, and pumps.
 - b. Provide 8 random inspections of air handlers and fan coil units (As determined by Owner or A/E).
 - c. Provide 4 random inspections of unit ventilators (As determined by Owner or A/E).

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5. Should any of these units not meet specifications as stated in the contract documents, it will be the contractor's responsibility to make all necessary repairs and provide, at their expense an independent TAB Agency (AABC or NEBB Certified) to recheck this equipment.

END OF SECTION 23 09 90

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SECTION 260010 – ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to all Division 26, 27 & 28 Specification Sections.

1.2 SCOPE OF PROJECT

- A. Provide a complete and operating electrical installation in accordance with these specifications and accompanying contract drawings. This includes all required labor, materials, apparatus, and supervision.

1.3 DESCRIPTIONS OF BASE BID AND ALTERNATE BID

- A. Refer to Section 012300.

1.4 UNIT PRICE ITEMS

- A. Refer to Section 012129 and 012200.

1.5 RULES AND REGULATIONS

- A. Perform in accordance with the rules and regulations of the National Electrical Code (NEC), International Building Code (IBC) and other Codes and Standards cited in this specification and the requirements of the utility companies serving the project site.
- B. Certificates of Approval in triplicate, for rough and finished wiring, from a Certified Inspection Service must be delivered to the Engineer before final payment can be authorized.
- C. Perform all work in accordance with the rules and regulations of the Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration) and any other national, state, or local authority having jurisdiction.
- D. Perform all Construction, design, fabrication, tests, rating, and installation in compliance with the regulations of all local, state, or national agencies having jurisdiction over the project. Pay all costs involved in work necessary to comply with these regulations.
- E. The Contractor assumes all responsibility and liability for any code violations, damage or injury which occurs as a result of a deviation from or a change to the requirements of these plans and specifications which has not been approved in writing by the Engineer.
- F. Consider the National Electrical Code, and the other codes and standards cited herein as providing the minimum construction standards for this project. Conform to all additional requirements and limitations contained in these plans and specifications as indicated.
- G. The intent of these drawings and specifications is to define the scope-of-work and standards of quality for the project. The Contractor is responsible for understanding and following the requirements of the codes and standards referenced by these documents. The Contractor shall be responsible for costs associated with changes when a code enforcement official determines that work does not comply with referenced codes and standards.

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1.6 DEFINITIONS

- A. General - Basic Contract definitions are included in the Conditions of the Contract.
- B. Indicated - The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.
- C. Directed - Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the Architect, requested by the Architect, and similar phrases.
- D. Approved - The term approved, when used in conjunction with the Architect's action on the Contractor's submittals, applications, and requests, is limited to the Architect's duties and responsibilities as stated in the Conditions of the Contract.
- E. Regulation - The term regulation includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. Furnish - The term furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. Install - The term install describes operations at the Project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. Provide - The term provide means to furnish and install, complete and ready for the intended use.
- I. Contractor - The Contractor or Electrical Contractor - The term means the Contractor responsible for all work under this Division.
- J. Installer - An installer is the Contractor, or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
 - 1. The term experienced, when used with the term installer, means having a minimum of five previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.
 - 2. Trades - Using terms such as carpentry is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as carpenter. It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.
 - 3. Assigning Specialists - Certain Sections of the Specifications require that specific construction activities be performed by specialists who are recognized experts in those operations. The specialists must be engaged for those activities, and their assignments are requirements over which the Contractor has no choice or option. However, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.
 - a. This requirement is not to be interpreted to conflict with enforcing building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.
- K. Project Site is the space available to the Contractor for performing construction activities either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project site is shown on the drawings and may or may not be identical with the description of the land on which the Project is to be built.
- L. Testing Agencies - A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

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M. AHJ – Authority(ies) Having Jurisdiction

N. Abbreviations and Names - Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations, as referenced in Contract Documents, are defined to mean the associated names.

1. AAHTO American Association of State Highway and Transportation Officials
2. ACI American Concrete Institute
3. AISC American Institute of Steel Construction
4. AISI American Iron and Steel Institute
5. ANSI American National Standards Institute
6. ASTM American Society for Testing and Materials
7. AWS American Welding Society
8. CBM Certified Ballast Manufacturers Assoc.
9. CRSI Concrete Reinforcing Steel Institute
10. EIA Electronic Industries Assoc.
11. ETL ETL Testing Laboratories Inc.
12. FM Factory Mutual Research Organization
13. ICEA Insulated Cable Engineers Association, Inc.
14. IEC International Electrotechnical Commission
15. IEEE Institute of Electrical and Electronic Engineers
16. IESNA Illuminating Engineering Society of North America
17. IMSA International Municipal Signal Association
18. ISA Instrument Society of America
19. LPI Lighting Protection Institute
20. NEC National Electrical Code
21. NECA National Electrical Contractors Assoc.
22. NEMA National Electrical Manufacturers Assoc.
23. NETA International Electrical Testing Assoc.
24. NFPA National Fire Protection Assoc.
25. UL Underwriters Laboratories, Inc.

O. Federal Government Agencies - Names and titles of federal government standard- or Specification-producing agencies are often abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard- or Specification-producing agencies of the federal government. Names and addresses are subject to change but are believed to be, but are not assured to be, accurate and up to date as of the date of the Contract Documents.

1. CFR Code of Federal Regulations
2. EPA Environmental Protection Agency
3. FAA Federal Aviation Administration (US Department of Transportation)
4. FCC Federal Communications Commission
5. FS Federal Specification (from GSA); Specifications Unit (WFSIS)
6. MIL Military Standardization Documents (US Department of Defense)
7. Naval Publications and Forms Center
8. OSHA Occupational Safety and Health Administration (US Department of Labor)
9. REA Rural Electrification Administration (US Department of Agriculture)

1.7 DRAWINGS

- A. The accompanying drawings are a part of the contract documents and are intended to show approximate and relative locations of services and equipment. Do not scale drawings to determine exact positions, locations, and clearances.
- B. Due to the diagrammatic layout and small scale of the drawings exact dimensions are not shown. Coordinate location and position of equipment with all other trades and the Engineer. Bring any discrepancies or interferences to the attention of the Architect and/or Engineer for clarification.
- C. All drawings and specifications pertaining to general construction, plumbing, HVAC, kitchen, electrical and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to coordinate with other trade, this Contractor shall rearrange his work at his own expense.

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D. The following electrical abbreviations may or may not be used on this project:

A	Amperes
AC	Ceiling/Rooftop Air Conditioner
AF	Amp Fuse
AFC	Above Finished Ceiling
AFF	Above Finished Floor
AFG	Above Finished Grade
AH	Air Handler
AHAP	As High As Possible
AIC	Asymmetric Interrupting Current
APMP	Area Protection Monitor Panel
ARCH	Architect
AT	Amp Trip
ATS	Automatic Transfer Switch
B	Boiler
BD	Bus Duct
BFC	Below Finished Ceiling
BH	Baseboard Heater
C	Conduit
CH	Cabinet Heater / Chiller
CHL	Chiller
CP	Circulating Pump
CT	Cooling Tower
CU	Condensing Unit
DB	Direct Burial
DEH	Dehumidifier
DH	Duct Heater
DWG	Drawing
DWGS	Drawings
EC	Electrical Contractor
ECB	Enclosed Circuit Breaker
ECH	Electric Cabinet Heater
EDH	Electric Duct Heater
EL	Elevation
ELEV	Elevator
EM	Emergency
EMT	Electrical Metallic Tubing
ETR	Existing To Remain
EWC	Electric Water Cooler
EX	Existing or Existing To Remain, U.O.N.
EXR	Existing To Be Removed, U.O.N.
FA	Fire Alarm
FAAP	Fire Alarm Annunciator Panel
FACP	Fire Alarm Control Panel
FAEP	Fire Alarm Extender Panel
FC	Fan Coil
FD	Fire Damper
FPV	Fan Powered Variable Air Volume
FDS	Fused Disconnect Switch
FIN. FL.	Finished Floor
FIN.GR.	Finished Grade
FPC	Fire Protection Contractor
GALV	Galvanized
GC	General Trades Contractor
GEN	Generator
GND	Ground
GRC	Galvanized Rigid Steel Conduit
GRD	Ground
HH	Handhole
HP	Heat Pump
HRU	Heat Recovery Unit
HWH	Hot Water Heater

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IDF	Intermediate Distribution Frame (Data) / Floor Distributor
IMC	Intermediate Steel Conduit
JB	Junction Box
KEC	Kitchen Equipment Contractor
KVA	Kilovolt Amperes
KW	Kilowatts
MC	Mechanical Contractor
MCB	Main Circuit Breaker
MDF	Main Distribution Frame (Data) / Building Distributor
MDP	Main Distribution Panel
MH	Manhole
MFS	Main Fused Switch
MLP	Main Lug Only
MTGB	Main Telecommunication Grounding Busbar
MTD	Mounted
MTS	Manual Transfer Switch
N	Neutral / Grounded Conductor
NATS	Non-automatic Transfer Switch
N/E	Normal-Emergency
NEC	NFPA 70 – National Electrical Code
NIC	Not In Contract
NFDS	Non-fused Disconnect Switch
NL	Nightlight
PB	Pull Box
PC	Plumbing Contractor
PH	Phase
PNL	Panelboard
PTAC	Packaged Through-the-wall Air Conditioner
RC	Rigging Contractor (Theatrical)
(REF)	Item Shown For Reference Purposes Only, Not Provided by EC, U.O.N.
REF.	Refrigerator
REFRIG	Refrigerator
RFG	Refrigerator
RTU	Roof Top Unit
SD	Smoke Damper
SF	Supply Fan
SWB	Switchboard
TBB	Telecommunication Backbone
TC	Telecommunication/Low Voltage/Systems Contractor
TGB	Telecommunication Ground Busbar
TVSS	Transient Voltage Surge Suppression
TYP	Typical
UH	Unit Heater
UG	Underground
U.O.N. Unless	Otherwise Noted
UON	Unless Otherwise Noted
UV	Unit Ventilator
V	Volts
VA	Variable Air Volume Box
VAV	Fan-powered Variable Air Volume Box
VS	Ventilating and Supply Unit
W	Wire
WC	Water Cooler
WG	Wire Guard
WH	Wall Heater
WP	Weatherproof / Weather Protected
XFMR	Transformer

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1.8 SUBMITTAL OF SHOP DRAWINGS FOR REVIEW

- A. Submit shop drawings with a letter of transmittal to the Architect per requirements of the General Conditions and Architects instructions.
- B. Properly prepare submittals before transmitting to the designated reviewer.
 - 1. Prepare an individual submittal package for each related group of materials.
 - 2. Refer to individual 260000 Sections for materials to be submitted for review and approval.
 - 3. Collate all items to be submitted as required by Division 1 consisting of one copy of each item. Permanently bind together by staples or other means all pages in each set.
 - 4. Bind with each set a typed cover sheet showing the date, project name, project location, Engineer's name, Contractor's name, Specification Section, and an index of all items included.
 - 5. Provide space on the cover sheet for the approval stamps of the Subcontractor, Contractor, Engineer, and Architect. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
 - 6. Clearly mark each page in the submittal set to show the manufacturer's name.
 - 7. When a page shows more than one item or catalog number, mark the item and catalog number which is proposed for use. Show all accessories, options and appurtenances which are required or which the Contractor desires to use.
 - 8. Improperly prepared submissions will be returned without action.
- C. All disapproved submittals shall be corrected as directed by the Architect/Engineer and resubmit the same quantity as originally submitted until approved. No work involving any materials or equipment covered by shop drawings shall be started until the respective shop drawings are approved.
- D. All items requiring shop drawing review shall not be installed until final approval has been given by the Architect/Engineer.

1.9 SUBSTITUTIONS

- A. All substitutions must be submitted in accordance with Division 1 requirements.
- B. Substitutions submitted not in accordance with Division 1 requirements will be returned without review.
- C. All costs involved in changes in the building, to the equipment, to the arrangement of equipment, or to the work performed or to be performed under other sections of the specifications, due to the substitution of equipment in lieu of that shown on the drawings or specified, shall be borne by the Contractor making such substitutions, and shall include, but not necessarily be limited to, costs or fees in connection with resubmission of drawings for approval, if required, by the Commonwealth of Pennsylvania, local authorities or insuring agencies having jurisdiction over the work.

1.10 SUBMITTALS FOR CLOSEOUT

- A. Record Drawings: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, Subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the mark-up before enclosing concealed installations.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Addendum Changes
 - b. Dimensional changes to Drawings.
 - c. Revisions to details shown on Drawings.

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- d. Depths of foundations below first floor.
 - e. Locations and depths of underground utilities.
 - f. Revisions to routing of cable tray and conduits.
 - g. Revisions to electrical circuitry.
 - h. Actual equipment locations.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
 7. Provide one (1) hard copy and one (1) PDF electronic file on digital media acceptable to Architect/Engineer for Owner. Provide one (1) additional PDF electronic file for the Engineer.
- B. O&M Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Enable bookmarking of individual documents based upon file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel upon opening file.
 3. Provide two (2) copies of the PDF electronic files on digital media acceptable to Architect/Engineer. One copy shall be for the Owner and the other shall be for the Engineer.
- C. O&M Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.
1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2" x 11" paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders, if necessary, to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL", Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
 4. Supplementary Text: Prepared on 8-1/2" x 11" white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.
 6. Provide three (3) hard copies for Owner. Submit to Architect/Engineer for review and approval.
- D. The Contractor shall submit 3 copies of the final wiring certificates.

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- E. The Contractor shall submit a copy of the Project Warranty

1.11 WARRANTY

- A. The Contractor shall submit the following guarantee:
 - 1. Written one (1) year full warranty guarantees shall be submitted for the entire electrical installation installed under this project (except lamps). The warranty shall begin at substantial completion of the project. If the manufacturer's warranty begins when the equipment ships or is ordered, then the Contractor shall extend the warranty to cover the construction period plus the warranty specified under substantial completion. If the manufacturer's standard guarantee provides for a longer period, the longer period shall apply.
 - 2. Where defects in the material, equipment and/or workmanship become evident within this guarantee period, the Contractor shall be responsible for providing new manufacturer approved material and equipment, and/or correcting the defective workmanship without any costs to the Owner.

1.12 INSPECTION

- A. Inspections of electrical work will be made by an agency hired by the Contractor.
- B. Contractor shall pay all inspection fees and submit 3 copies of final wiring certificates to Architect.

1.13 VISIT TO THE SITE

- A. Prior to submission of bid, the Contractor is required to visit the site to become acquainted with existing conditions. Bids as submitted will be interpreted to include all costs and changes made necessary by such conditions. Refer to the pre-bid meeting schedule in invitation to bid.

1.14 COORDINATION OF WORK

- A. Coordination and meetings: Coordinate the installation of all interior and exterior products and systems specified for this construction project including those specified under multiple prime contracts in accordance with Division 1.
- B. Coordination with Various Trades: Contractor shall coordinate space and installation requirements of all work, including underground utilities, which is indicated diagrammatically on drawings, with the project manager, respective contractors, and Utility Company's prior to starting any work. In case of interference or problems, the Architect shall decide which work is to be relocated, regardless of which work is installed first, at no additional cost. See Division 1 General Requirements.
- C. The Contractor shall prepare dimensioned arrangement drawings at a scale of (1/4" - 1") to be utilized by all contractors for coordination. Each contractor shall be required to, and responsible for, adding their respective work to those coordination drawings. Each contractor shall coordinate with all other trades to fit all equipment and materials in allocated space. Completed coordination drawings shall be submitted to Architect/Engineer for review.

1.15 LOCATION OF EQUIPMENT AND OUTLETS

- A. Request detailed and specific information regarding the locations of all equipment as the final location may differ from that indicated on the drawings.

1.16 MATERIAL QUALITY

- A. Use the best grade and quality items in commercial practice. Provide the manufacturer's name, address, and catalog number on a plate securely affixed in a convenient place. All electrical equipment or apparatus of any one system must be the product of one manufacturer, or equivalent products of a number of manufacturers, which are suitable for use in a unified system.

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- B. Furnish products listed and classified by Underwriters Laboratories, Inc., or other testing firms acceptable to the authority having jurisdiction.

1.17 WORKMANSHIP

- A. Execute all work utilizing qualified and competent employees in a manner consistent with good workmanship. Install all equipment in accordance with Engineer's approved shop drawings and manufacturer's recommendations.
- B. Firmly support and secure to the building construction all materials and equipment. Use only approved hardware and methods as described in these Specifications.

1.18 PROTECTION OF EQUIPMENT AND MATERIALS

- A. Responsibility for care and protection of electrical work rests with Contractor until it has been tested and accepted. Refer also to specific requirements in each section of this specification.

1.19 SCAFFOLDING AND HOISTING

- A. The Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install all systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.
- B. Contractor shall hoist or rig his own material and equipment into place or arrange for the rigging of it by others at his expense.

1.20 FOREMAN

- A. Contractor must provide a competent foreman, subject to approval of the Architect. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours.
- B. Any instructions or notices given to the foreman shall have the same force as if given to the Contractor in person.

1.21 EXCAVATION AND BACKFILL

- A. The Electrical Contractor shall provide all excavation and backfilling and all shoring, sheeting, pumping, and other work incidental to excavating as required for the installation of electrical work. Refer to Division 31 & 32.
- B. All repair of macadam or concrete paving made necessary by work done under this contract shall be performed by the Electrical Contractor at the expense of this Contractor as required by the specifications. All such repairs shall match surrounding paving in materials and workmanship. Work shall comply with the appropriate sections of the General Specification.
- C. All grading and seeding made necessary by work done under this contract shall be performed by the Electrical Contractor as required by the specifications. Work shall comply with the appropriate sections of the General Specifications.
- D. All excavation is unclassified unless otherwise noted on the drawings or in Division 31 of the Specifications.
- E. Provide warning tape above all underground services, properly identifying each type of service.

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1.22 PAINTING

- A. All painting of electrical components and materials in finished area will be done under the general construction contract. If electrical components are installed after the area is painted or if no painting is scheduled by the General Contractor, the Electrical Contractor shall be responsible to paint the electrical components.
- B. Factory painted and galvanized finishes which are damaged before the Owner occupies the building shall be repaired with matching paint or cold galvanizing compound respectively. Touch-up of factory finishes shall be done by the Electrical Contractor.

1.23 CUTTING AND PATCHING

- A. This Contractor shall be responsible for all cutting and patching required for installation of work on this project. Cutting and patching methods shall conform to the requirements for new construction contained in other sections of this specification.
 - 1. Patching in surfaces that will remain visible when the project is finished shall be identical in appearance to the undisturbed surface.
 - 2. Patches in fire rated walls, ceilings and floors shall maintain the fire rating of these barriers by use of approved materials including special fire rated sealing compounds or materials identical to the barrier materials. Refer to the Architectural Specifications for approved methods and materials.
 - 3. Refer to Division 1 for additional requirements.

1.24 WORK SEQUENCE

- A. Refer to Architectural Drawings and Specifications for Phasing Requirements for this Project and the approved Contractors Phasing Schedule. This Contractor shall plan and coordinate his work in accordance with those requirements. Provide any and all temporary electrical lighting, power and system modifications to keep the occupied areas in service and maintained by the respective contractor.

1.25 CLEANING AND FINISHING

- A. After all tests have been made and the system proven satisfactory to the Architect, the Contractor shall go over the entire project, clean all equipment and material installed by him, and leave in a clean and working condition.

1.26 PERFORMANCE OF EQUIPMENT

- A. Provide materials, equipment, and appurtenances of any kind, shown on the drawings, hereinafter specified, or required for the completion of the work in accordance with the intent of these specifications, which are completely satisfactory and acceptable in operation, performance, and capacity. Approval, either written or verbal, of any drawings, descriptive data or samples of such material, equipment, and/or appurtenance does not relieve the Contractor of his responsibility to turn over the same to the Owner in perfect working order at the completion of the work.
- B. Replace any materials, equipment, or appurtenances, the operation, capacity, or performance of which does not comply with the drawings and/or specification requirements or which is damaged prior to acceptance by the Owner with proper and acceptable items in working order, satisfactory to the Engineer and Architect without additional cost to the Owner.

1.27 ACCESS

- A. Furnish and erect all scaffolding and ladders required in the installation of wiring, equipment, and fixtures.

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1.28 ANCHOR BOLTS

- A. Provide and set in place, at the time of pouring of concrete foundations, all necessary anchor bolts as required for the equipment called for under these specifications. Provide anchor bolts of the hook type, of proper size and length to suit the equipment. The Contractor is responsible for proper emplacement of the bolts and must have representative present at the time foundations are poured.

1.29 INSERTS

- A. Where desired in cast in place concrete, provide and install inserts of an approved type. Where two or more parallel conduits are installed, continuous inserts may be used. Where required to distribute the load on the inserts, install a piece of reinforcing steel of sufficient length through the inserts.

1.30 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4" larger, in both directions, than supporting unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3.
- B. Provide minimum 4" high bases for all floor mounted equipment unless noted otherwise.

1.31 ACCESS PANELS

- A. Provide panels with fire ratings equal to the surface in which they are installed and be 12" x 12" or 4" larger than each dimension of the enclosed box, whichever is greater.

1.32 TESTING, ADJUSTING, AND BALANCING

- A. Make all connections at panels and switches; make all splices and taps. Install fuses in all fuse holders. Complete all circuits from power sources to loads at the time of final inspection.
- B. Upon completion of the work, test all parts of the electrical installation to ensure that it is free of unwanted grounds and other defects. Preliminary testing with continuity meters will be permitted but will not be accepted in obtaining final results. Make final tests with a megger.
- C. Check load balance and rearrange connections so that the KW demand on each of the phase conductors does not vary by more than 10%.
- D. Set all overload devices, including equipment furnished under other contracts, and adjust to suit the load conditions. Make selections in accordance with NEC requirements and manufacturer's instructions.
- E. Ensure that all covers, closures, doors, and plates are in place.
- F. Ensure that all trims and covers are adjusted to be parallel or perpendicular to building lines, tight against surrounding architectural finishes, and devices are set flush.
- G. Check devices and controls for proper mechanical and electrical operation and set to normal or appropriate positions at the time of contract closeout.

1.33 EXAMINATION OF CONTRACT DOCUMENTS

- A. Carefully examine the architectural, civil, structural, heat-ventilating - air conditioning, plumbing and sprinkler drawings. If any discrepancies occur between the drawings or between the drawings and the specifications, report such discrepancies to the Engineer and the Architect in writing in a Request For Information (RFI)

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form and obtain written instructions as to the manner in which to proceed. Make no departures from the contract drawings without prior written approval of the Architect/Engineer.

- B. Report any discrepancies prior to the submission of bid. In the event such discrepancies are not reported and claims for extra charges to the contract result, such claims will be allocated to and paid for by the Contractor, who, in the opinion of the Engineer and the Architect, is the responsible party.

1.34 EQUIPMENT WIRING - GENERAL

- A. Unless otherwise mentioned herein or shown on the drawings, provide power wiring to all equipment, associated controls, and appurtenances. Refer to Specifications Section 260180 for further information on equipment provided under the electrical and other contracts.

1.35 FOOD SERVICE EQUIPMENT

- A. All 15 and 20 ampere receptacles, in kitchens and other areas, for food service equipment shall be of the ground fault (GFCI) type or be fed by a ground fault (GFCI) type breaker. Unless otherwise noted, provide ground fault type receptacles.

1.36 TEMPORARY FACILITIES

- A. Provide temporary electric and lighting as required by Division 1.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 MOUNTING HEIGHTS AND LOCATION

- A. Outlets, controls, and system components shall be mounted at the heights listed below unless otherwise indicated. Heights shall be measured to the centerline of the box from the finished floor unless otherwise noted.
 - 1. Wall Switches: 42"
 - 2. Receptacle Outlet (General): 1'-6" unless indicated otherwise
 - 3. Receptacle Outlet (Mechanical, Storage, Electrical, Unfinished Rooms): 42"
 - 4. Telephone Outlet: 1'-6" unless indicated otherwise
 - 5. Data Outlet: 1'-6" unless indicated otherwise
 - 6. Wall Intercom Station: 46"
 - 7. Raise/Lower Switch: 42"
 - 8. Clock Outlet: 8'-0" when possible. Allow space below ceiling to service or replace. Above doors, center between door trim and ceiling.
 - 9. Bells, Buzzers, Chimes: 8'-0" when possible. Allow space below ceiling to service or replace. Above doors, center between door trim and ceiling.
 - 10. Fire Alarm Devices: Refer to Fire Alarm Section.
 - 11. Television Outlet: 1'-6" unless indicated otherwise.
 - 12. Microphone Inlet: 1'-6" unless indicated otherwise.
 - 13. Receptacles above counters or benches with full height or no backsplashes: 0'-8" above countertop.
 - 14. Range Outlet: Verify location and mounting height with Architect before roughing-in.
 - 15. Water Cooler Outlet: Verify location and mounting height with Plumbing Contractor before roughing-in.
- B. Equipment shall be mounted as follows:
 - 1. Safety Switches: 5'-0" to top of enclosure.
 - 2. Enclosed Circuit Breakers: 5'-0" to top of enclosure.
 - 3. Enclosed Motor Controllers: 5'-0" to top of enclosure.
 - 4. Enclosed Contactors: 5'-0" to top of enclosure.
 - 5. Time Controls: 5'-0" to top of enclosure.

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6. Combination Starters: 5'-6" – 6'-0" to top of enclosure.
 7. Panelboards: 6'-6" to top of enclosure.
- C. When specifically detailed in the Architectural or Electrical drawings, mounting heights are to be as indicated. Consult architectural plans and elevations for individual areas where device locations may conflict with other work.
- D. In general, coordinate all device locations with approved Casework Drawings, Architectural Elevation, and Drawings, Mechanical, Plumbing, approved Kitchen and Room Equipment Drawings and other applicable drawings.
- E. Locate outlets in commercial kitchens in accordance with approved Food Service Drawings or shop drawings.
- F. In lavatories or rooms with casework or fixed cabinets, coordinate mounting heights and locations in the field with architectural elevations and adjust as required to avoid conflicts with mirrors, back splashes, fixtures, and hardware items.
- G. Field verify the final rough-in location for the actual equipment to be connected.
- H. Lighting Fixtures: As scheduled or indicated.
- I. Throughout new installation, all raceways and boxes shall be installed so that they are concealed in new construction. Any exceptions shall be approved by Architect before installation.

3.2 CEILING TILE REMOVAL

- A. The Contractor shall remove and replace ceiling tile and grid work as required for the installation of electrical work. Damaged tile and grid shall be replaced by the Contractor and shall match the existing ceiling system.

3.3 LINTEL COORDINATION

- A. All electrical sleeves and lintels that need to penetrate NEW walls are to be provided by Electrical Contractor for their work as detailed on the Masonry Lintel Schedule on the Structural Drawings provided to the General Contractor and installed by the General Contractor during construction of walls. If Electrical Contractor does not coordinate prior to construction of walls with the General Contractor, the Contractor is responsible to cut, install, and patch walls for the installation of their sleeves, lintels, and work. Electrical Contractor is also responsible for their own cutting and patching of existing walls and installation of sleeves, lintels to allow for their work.

END OF SECTION 260010

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SECTION 260060 – ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electrical Demolition

1.2 RELATED WORK/DIVISIONS

- A. Division 2

1.3 SCOPE

- A. Refer to Drawings for Scope-of-Work

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Provide materials and equipment for patching and extending work approved by Architect/Engineer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that building conditions are as shown on Drawings. Report discrepancies to Architect/Engineer before disturbing existing installation.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition Drawings are based on casual field observation. Report discrepancies to Architect/Engineer before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

3.2 COORDINATION

- A. All electrical removals shall be coordinated with the removal and construction schedules of the other contractors working on this project so that the construction schedule may proceed without delays and interferences. Removals shall be complete before new work is started except portions of the removal which are designated for temporary use.
- B. Coordinate with the Mechanical and Plumbing Contractors for exact quantities and location of equipment to be disconnected and removed. The Electrical Contractor is responsible for removal of all electrical items serving mechanical equipment that is to be removed.
- C. Coordinate with the Mechanical and Plumbing Contractors for exact quantities and location of equipment to remain and/or to be relocated. Provide new disconnects, wire and conduits, same size as existing, and reconnect equipment as required.

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- D. Maintain electrical service and emergency power system as required during phasing. Provide rework of systems as required.
- E. Removals of system specific equipment shall be performed by installer of such equipment so that a phased switchover of systems is facilitated.

3.3 PREPARATION

- A. Disconnect and remove electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Coordinate utility service outages with Utility Company and Owner.
- C. Provide temporary wiring, supporting devices and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Maintain the following systems in service until new service is complete and ready for service. When system is to remain provide all rework required to maintain system operational. Systems shall only be disabled to make switchovers and connections. Provide temporary connections to maintain service in areas adjacent to work area. Obtain permission from Architect/Engineer at least 72 hours before partially or completely disabling systems, minimizing outage duration.
 - 1. Electrical Service
 - 2. Telephone Service
 - 3. CATV Service
 - 4. Fiber Service
 - 5. Fire Alarm System
 - 6. Telephone System
 - 7. Television System
 - 8. Computer Network System
 - 9. Security/Card Access Systems
 - 10. Sound Systems
 - 11. Program/Master Clock Systems
 - 12. Generator Systems

3.4 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work under provisions of Division 2 and Division 26.
- B. In areas where existing surfaces and structures are to remain, all electrical equipment and materials designated for removal shall be disassembled where possible and neatly cut where necessary to avoid damaging surfaces and structures. Where damage to existing surfaces and structures occurs, the contractor shall be responsible for repairs using proper materials as specified in other sections of this specification and as directed by the Architect/Engineer.
- C. Where items of equipment or materials are designated to be turned over to the Owner, such equipment and material shall be carefully removed and reassembled or packaged in order to avoid damage and loss of parts. The Contractor shall be responsible for repair of damage and replacement of lost parts.
- D. Demolished equipment and materials shall be removed from the work area by the end of each workday and more frequently when necessary to avoid congestion and hazardous conditions. Demolished equipment and materials shall be removed from the site at least once a week and more frequently when necessary to avoid congestion and hazardous conditions. Materials shall be carefully stacked or boxed as they are removed to avoid the safety hazards associated with cluttered work areas and unstable stacks and piles.
- E. All demolished materials and equipment not designated to be turned over to the Owner shall become the property of the Contractor. The contractor shall dispose of these materials and equipment in accordance with the applicable requirements of local, state, and federal authorities having jurisdiction.

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- F. Removals shall be complete and shall include all attachments, brackets, hangers, cables, clamps, hardware, bolts, and screws. Cast in place and expanded anchors do not need to be removed where they are flush with the surface, but protruding studs shall be cut off flush.
- G. Where removals disrupt service to existing circuits and equipment which is to remain, the Contractor shall restore service to the remaining equipment and outlets using the construction methods and materials permitted or required by the appropriate sections of this specification.
- H. Remove, relocate, and extend existing installations as required to accommodate new construction.
- I. Remove abandoned wiring to source of supply.
- J. Remove exposed abandoned conduit, including abandoned conduit and cables above accessible ceiling finishes. Cut conduit to 1" below surface of walls and floors, and patch surfaces.
- K. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit and cables servicing them is abandoned and removed. Remove the backbox and patch/paint the wall to match the existing surfaces.
- L. Disconnect and remove abandoned panelboards and distribution equipment.
- M. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- N. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- O. Repair adjacent construction and finishes damaged during demolition and extension work.
- P. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- Q. Extend existing installations using materials and methods as specified.
- R. Remove any acoustical tile or ceiling material not removed by other trades, as required for the removal of existing and/or the installation of new electrical equipment. Contractor shall replace all ceiling tiles damaged by him that are to remain. New ceiling tiles shall match existing type. Verify type with Architect before installing.
- S. Repair fire and smoke rated partitions surrounding electrical work as specified. Refer to the Architectural Plans for locations of smoke and fire partitions.
- T. Remove abandoned telecommunications and low voltage cables from terminal to outlet. Remove abandoned outlets and terminal cabinets.
- U. Where demolition of electrical equipment damages existing surfaces that are to remain, restore those surfaces to the same condition as the adjacent surfaces. All patches and repairs shall be subject to review and approval by the Architect. When the Room Finish Schedule shows that a room will be painted under another contract, prime the wall and ceiling patches ready for finish painting. Where room finishes are not part of another contract, prime and paint wall and ceiling patches to match existing surfaces. Blank plates will not be acceptable for removed equipment including flush panelboards.

3.5 POLYCHLORINATED BIPHENYL MATERIAL

- A. Testing:
 - 1. The Contractor shall be responsible for the proper testing of all waste and expendable materials, including PCB fluid in accordance with local, state, federal regulations, ASTM D923 and D4059.
 - 2. All PCB fluids and PCB contained materials shall be transported by an approved hazardous materials company. Receipts and certificates of testing for each container of fluid and contaminated waste shall be provided to the Owner.

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- B. Disposal:
 - 1. All ballasts containing PCB's and batteries shall be treated as hazardous waste and be disposed of as regulated by the Environmental protection Agency's Universal Waste Rule. Any state regulations more stringent shall take precedence.
 - 2. All fluorescent and HID lamps shall be treated as hazardous waste and be recycled as regulated by the Environmental Protection Agency's Universal Waste Rule. Any state regulations more stringent shall take precedence.
 - 3. All transformers containing PCB's shall be treated as hazardous waste and be recycled as regulated by the Environmental Protection Agency's Universal Waste Rule. Any state regulations more stringent shall take precedence.
- C. Guarantee: The Contractor shall guarantee that all hazardous materials have been removed from the Owner's property and disposed of properly and that the existing structure is free of contamination by any hazardous materials removed for this project.

3.6 SALVAGE

- A. The items indicated on the drawings shall be carefully removed, protected, and turned over to the Owner in the condition which existed before their removal. The Contractor shall transport the salvaged items with his own manpower to the Owner designated place located on site or re-install the items as shown on the drawings.

3.7 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Reused Luminaires: Provide new lamps, ballasts, lenses and replace all broken electrical parts. Clean entire luminaire as recommended by manufacturer.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

3.8 INSTALLATION

- A. Install relocated materials and equipment under the provisions of Division 2.

END OF SECTION 260060

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SECTION 260180 – EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electrical Connections to Equipment Specified under other Sections

1.2 RELATED WORK/DIVISIONS

- A. Division 1 – GENERAL REQUIREMENTS
- B. Division 8 – OPENINGS
- C. Division 10 – SPECIALTIES
- D. Division 11 – EQUIPMENT
- E. Division 12 – FURNISHINGS
- F. Division 14 – CONVEYING EQUIPMENT
- G. Division 21 – FIRE PROTECTION
- H. Division 22 – PLUMBING
- I. Division 23 – MECHANICAL

1.3 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code
- B. NEMA WD 1 – General Purpose Wiring Devices
- C. NEMA WD 6 – Wiring Device Configurations

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.5 COORDINATION

- A. Coordinate work under provisions of Section 260010.
- B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- C. Verify voltage of equipment matches source before energizing power.
- D. Determine connection locations and requirements.

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- E. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- F. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.6 ELECTRICAL EQUIPMENT BY OTHERS

- A. Provide all power and control wiring for products furnished and installed under contracts for Divisions 2 through 14. Switches, pushbuttons, indicator lights and control panels are supplied as part of the equipment package unless otherwise noted on the drawings.
- B. Provide power wiring and disconnect means for kitchen equipment supplied by others. Unless noted otherwise, provide wiring between equipment and starter, and/or disconnect as required for a complete installation. Consult the Architectural, Food Service Equipment (Kitchen), and Electrical Drawings for electrical work to be performed. Provide all necessary wiring and make final connections to all kitchen equipment and to the Kitchen Hood's Fire Suppression System as required by the Food Service Contractor.
- C. Provide power wiring for equipment as provided under the Mechanical (Heating-Ventilating-Air Conditioning) and Plumbing Contracts. Complete all electrical power connections through the disconnect and starter to motor or load terminals. Control wiring and overload protection for this equipment is the responsibility of the Mechanical or Plumbing Contractors. Provide disconnect means for all mechanical and plumbing equipment as follows:
 - 1. Provide disconnect means for all 3-phase equipment. Mount switch adjacent to motor or load terminals.
 - 2. Provide thermal overload switches for all single-phase motors and single-phase equipment. Mount the switch adjacent to the motor or load terminals.
- D. Motorized Coiling Door:
 - 1. Provide fused disconnect switch and wire thru to coiling door.
 - 2. Coordinate size and voltage of disconnect switch with approved shop drawing.
 - 3. Provide all control/safety wiring in 3/4" conduit and install switches furnished with unit.
- E. Motorized Overhead Door:
 - 1. Provide local disconnect switch and wire thru to door.
 - 2. Coordinate size and voltage of disconnect switch with approved shop drawing.
 - 3. Provide all control/safety wiring in 3/4" conduit and install controls furnished with unit.
- F. Motorized Shade Motor:
 - 1. Provide line voltage boxes/wiring and conduit as required by the manufacturer.
 - 2. Provide low voltage boxes/wiring and conduit as required by the manufacturer.
 - 3. Provide all control wiring in 3/4" conduit and install switches furnished with system.

1.7 DIVISION 21, 22, and 23 POWER REQUIREMENTS

- A. Refer to Mechanical, Plumbing, and Fire Protection Schedules on Drawings and Division 21, 22, and 23 Specifications. For the power requirements which were the basis of design, confirm the actual power before ordering/installing, notify Architect/Engineer.

1.8 COORDINATION OF RESPONSIBILITIES

- A. Division of responsibility between Contractors shall be as indicated below.
- B. The respective contractor shall provide all items of material and equipment for the following:

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		DIV 23	DIV 26
1.	ATC System		
	a. Furnish and install unit	X	
	b. All control wiring between panels and remote-control equipment	X	
	c. All low voltage wiring to control devices	X	
	d. 2 Category 6 cables to main panel from nearest IDF/MDF Room		X
	e. Transformers for control	X	
	f. N/E Power Wiring to Main Panel		X
	g. N/E Power to all other Panels	X	

		DIV 23	DIV 26
2.	Fan Coils (FC)		
	a. Furnish and install unit	X	
	b. Thermal Toggle Switch		X
	c. Power wiring thru starter and disconnect to terminals		X
	d. Control wiring	X	

		DIV 23	DIV 26
3.	Split System Air Conditioners (AC)		
	a. Furnish and install unit	X	
	b. Thermal Toggle Switch		X
	c. Power wiring thru starter and disconnect to terminals		X
	d. Control wiring	X	

		DIV 23	DIV 26
4.	Split System Condensing Unit (CU)		
	a. Furnish and install unit	X	
	b. Fused Disconnect Switch		X
	c. Power wiring thru starter and disconnect to terminals		X
	d. Control wiring	X	

		DIV 23	DIV 26
5.	Unit Heaters and Cabinet Heaters (UH) (CH)		
	a. Furnish and install unit	X	
	b. Local Disconnect Switch		X
	c. Power wiring thru disconnect to unit		X
	d. Control wiring	X	

		DIV 23	DIV 26
6.	Pump Packages (CP) (VFD)		
	a. Furnish and install unit	X	
	b. Starter/Disconnect Switch	X	
	c. Power wiring thru starter and disconnect to terminals		X
	d. Control wiring	X	
	e. Control power transformer at starter	X	

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		DIV 23	DIV 26
7.	Domestic Hot Water Pumps, Sewage Ejector Pumps and Condensate Pumps (P-X)		
	a. Furnish and install unit	X	
	b. Thermal Toggle Switch/Fused Disconnect Switch		X
	c. Power wiring thru starter and disconnect to terminals		X
	d. Control wiring	X	
		DIV 23	DIV 26
8.	Exhaust Fans, Supply Fans and Propeller Fans (EF) (SF) (PF)		
	a. Furnish and install unit	X	
	b. Thermal Toggle Switch / Fused Disconnect Switch	X	
	c. Power wiring thru wall switch, disconnect switch, starter to unit		X
	d. Control wiring	X	
		DIV 23	DIV 26
9.	Indoor Air Handlers (AH)		
	a. Furnish and install unit	X	
	b. Starter	X	
	c. Fused Disconnect switch		X
	d. Power wiring thru disconnect and starter to terminals		X
	e. Control wiring	X	
	f. Smoke detector connected to building fire alarm system		X
	g. Control power transformer at starter	X	
		DIV 23	DIV 26
10.	Energy Recovery Units (ERU) (ERV)		
	a. Furnish and install unit	X	
	b. Starter	X	
	c. Fused disconnect switch fused per manufacturer/NEC		X
	d. Power wiring thru disconnect and starter to terminals		X
	e. Control wiring	X	
	f. Smoke detector connected to building fire alarm system		X
	g. Control power transformer at starter	X	
		DIV 23	DIV 26
11.	Boilers & Boiler Blend Pumps		
	a. Furnish and install unit	X	
	b. Starter/Controls	X	
	c. Fused disconnect switch fused per manufacturer/NEC		X
	d. Power wiring thru starter to terminals		X
	e. Control wiring	X	
	f. Emergency Boiler shutoff switches at exits	X	
		DIV 22	DIV 26
12.	Water Heaters		
	a. Furnish and install unit	X	
	b. Fused disconnect switch fused per manufacturer/NEC		X
	c. Power wiring thru disconnect to unit		X

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		DIV 22	DIV 26
13.	Flush Valves		
	a. Furnish and install unit	X	
	b. 120-volt wiring to transformer for multiple valves		X
	c. Transformer(s)	X	
	d. Low voltage wiring to flush valves	X	

		DIV 22	DIV 26
14.	Lavatory Faucets		
	a. Furnish and install unit	X	
	b. GFI receptacle at unit		X
	c. Transformer(s)	X	
	d. Low voltage wiring to valves	X	

		DIV 23	DIV 26
15.	Duct Smoke Detectors		
	a. Furnish duct smoke detector base, sampling tube, and weatherproof enclosure (where applicable)		X
	b. Install duct smoke detector base, sampling tube, and weatherproof enclosure (where applicable)	X	
	c. Furnish and install duct smoke detector, fire alarm control relay for AHU shutdown, and remote test station (where applicable)		X
	d. Fire alarm wiring to/from Fire Alarm Control Panel and wiring from relay to AHU controller (for AHU shutdown)		X

- C. The respective contractor shall provide all items of material and equipment for the equipment listed in the matrix.
- D. Any material and equipment not listed in the matrix shall follow the following requirements:
1. Starter/Controls by Division 21/22/23.
 2. Fused disconnect switch by Division 26.
 3. Additional items required by Division 21/22/23.

1.9 ROUGHING-IN REQUIREMENTS

- A. The Contractor shall provide complete roughing-in requirements, including conduit, power, and control wiring, etc. for the following items furnished under Divisions 8, 10, 11, 12, and 14, unless otherwise indicated on the drawings.
1. Motorized Folding Partition
 2. Motorized Overhead Doors
 3. Motorized Coiling Door
 4. Door Hardware
 5. Motorized Shades
 6. Kitchen Equipment
 7. Scoreboards
 8. Smoke Dampers
 9. Site Signs
 10. Ranges
 11. Dryers
 12. Water Coolers
- B. The equipment supplier shall provide wiring (point to point) diagrams where the Electrical Contractor is to make final connections.

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- C. Refer to approved shop drawings for roughing-in requirements.
- D. Provide power and interconnecting wiring to all equipment required by the Hardware Manufacturers. Doors shall operate as described in the notes of the Hardware Package.
- E. Contractor is responsible for damaged equipment if it has been connected without consulting the equipment suppliers point to point wiring diagrams.
- F. Throughout new installation, all raceways and boxes shall be installed so that they are concealed in new construction. Any exceptions shall be approved by Architect before installation.

PART 2 - PRODUCTS

2.1 CORDS AND PLUG SETS

- A. Refer to Section 260726

2.2 RACEWAY AND POWER CONDUCTORS

- A. Refer to Sections 260533 and 260519 as appropriate.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.
- B. Verify that all motors rotate in the correct direction. Correct the connections for motors which do not.
- C. Verify that unit requirements match specified circuit sizes. Notify mechanical contractor and engineer of any discrepancies.

3.2 ELECTRICAL CONNECTIONS

- A. Provide electrical connections in accordance with equipment manufacturer's instructions.
- B. Provide conduit connections to equipment using liquidtight flexible metallic conduit. Use liquidtight flexible metallic conduit with watertight connectors in damp or wet locations.
- C. Provide wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
- D. Provide receptacle outlet where connection with attachment plug as indicated or required. Provide cord and cap where field-supplied attachment plug as indicated or required.
- E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- F. Install disconnect switches, controllers, control stations, and control devices as indicated or required.
- G. Modify equipment control wiring with terminal block jumpers as indicated or required.
- H. Provide interconnecting conduit and wiring between devices and equipment as indicated or required.

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- I. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, or ceilings. Install a conduit seal fitting 24" outside of the refrigerated space and wrap conduit with 1/2" preformed pipe insulation. Fill conduit seal with approved filler compound.
- J. Modify as required for the installation of lug adapters, crimp-on reducers, and hardware, as necessary, to terminate conductors on equipment.

END OF SECTION 260180

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SECTION 260519 – ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conductors and Cables
- B. Metal Clad Cable
- C. Wiring Connectors and Connections

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
- B. NETA - ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (International Electrical Testing Association).

1.3 SUBMITTALS FOR REVIEW

- A. Submit a letter on company letterhead stating that all equipment is in compliance with the specifications.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.6 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Conductor sizes are based on copper. Substitution of aluminum for conductors specified as copper is not permitted.
- C. Conductor sizes are based upon 75°C insulation temperature ratings. When the contractor furnishes equipment that is listed for use with conductors having temperature ratings of less than 75°C, he shall furnish conductors sized in accordance with the 60°C column of NEC Tables 310-16 or 310-17 and the appropriate conduit size.
- D. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions. Include wire and cable lengths within 10' of length shown.
- E. Where wire and cable routing are not shown, and destination only is indicated, determine exact routing and lengths required.

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1.7 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 POWER CONDUCTORS

- A. Description: Single conductor insulated wire.
- B. Conductor: Copper, 98% conductivity minimum.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation: ANSI/NFPA 70; Type THHN/THWN or XHHW insulation for feeders and branch circuits.

2.2 METAL CLAD CABLE (See Wiring Methods, Paragraph 3.3 of this Section for Restrictions)

- A. Description: ANSI/NFPA 70, Type MC.
- B. Conductor: Copper
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation Temperature Rating: 75°C.
- E. Insulation Material: Thermoplastic
- F. Armor Material: Steel or Aluminum
- G. Armor Design: Interlocked metal tape
- H. Jacket: None

2.3 POWER & CONTROL SIGNAL METAL CLAD CABLE (See Wiring Methods, Paragraph 3.3 of this Section for Restrictions)

- A. Description: ANSI/NFPA 70, Type THHN/THWN power and ground conductors along with a control conductor assembly composed of a 30 mil PVC jacket covering two 16 AWG CU Type TFN control conductors.
- B. Conductor: Copper
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation Temperature Rating: 75°C.
- E. Insulation Material: Thermoplastic
- F. Armor Material: Steel or Aluminum
- G. Armor Design: Interlocked metal tape
- H. Jacket: None
- I. Usage: LED lighting with 0-10V dimming

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2.4 WIRING CONNECTORS AND SPLICES

- A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material and type and class for application and for service indicated.
- B. All wire connectors shall be manufactured in full compliance with UL 486A.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire and cable has been completed.

3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.3 WIRING METHODS

- A. Concealed Dry Interior Locations: Use only power conductors, type THHN/THWN or XHHW insulation, in raceway.
- B. Exposed Dry Interior Locations: Use only power conductor types THHN/THWN or XHHW insulation, in raceway.
- C. Above Accessible Ceilings:
 - 1. Home Runs: Use only power conductors, Type THHN/THWN or XHHW insulation, in raceway.
 - 2. In Corridors and for Circuits which extend to other rooms: Use only power conductors, type THHN/THWN or XHHW insulation in raceway.
 - 3. Branch Circuits which do not extend beyond the walls of the room: Use power conductors, type THHN/THWN or XHHW insulation in raceway or metal clad cable.
- D. Wet or Damp Interior Locations: Use only power conductors, type THHN/THWN or XHHW insulation, in raceway.
- E. Underground Installations: Use only power conductors, type XHHW in raceway.
- F. Exterior Locations: Use only power conductors, type THHN/THWN or XHHW insulation, in raceway.
- G. Wiring methods indicated on Drawings supersede the General Statements in this Section.
- H. MC Cable is specifically prohibited to penetrate walls to other spaces and prohibited above corridor ceilings other than short (10' or less) connections from raceway junction boxes to light fixtures and equipment.
- I. Throughout new installation, all raceways and boxes shall be installed so that they are concealed in new construction. Any exceptions shall be approved by Architect before installation.
- J. In renovation projects, MC Cable shall be used for existing fishable walls for new recessed devices and equipment. For larger than 30A circuits use flexible metal conduit (Greenfield) with the appropriate conductors.
- K. In underslab branch circuit raceways, there should be no less than one raceway extension installed from electrical device to an above accessible ceiling location terminated in a junction box per room. The intent of this requirement is to give future access to this raceway and circuits.

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3.4 INSTALLATION

- A. Install products in accordance with manufacturers' instructions.
- B. Use solid conductor for feeders and branch circuits 10 AWG and smaller.
- C. Use stranded conductors for control circuits.
- D. Use conductor not smaller than 12 AWG for power and lighting circuits.
- E. Use conductor not smaller than 16 AWG for control circuits.
- F. Pull all conductors into raceway at same time.
- G. Use suitable wire pulling lubricant for all building wire.
- H. Protect exposed cable from damage.
- I. Support cables above accessible ceiling, using spring metal clips or metal or plastic cable ties to support cables from structure. Do not support cables from ceiling suspension system. Do not rest cable on ceiling panels.
- J. Modify as required for the installation of lug adapters, crimp on reducers and hardware, as necessary, to terminate conductors on equipment.
- K. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- L. Clean conductor surfaces before installing lugs and connectors.
- M. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- N. Use split bolt connectors for copper conductor splices and taps No. 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150% of insulation rating of conductor.
- O. Use gutter taps for taps from parallel feeder cables.
- P. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
- Q. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- R. Cover ends of spare conductors with electrical tape.
- S. Conductor Splices: Keep to minimum.
 - 1. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
 - 2. Use splice and tap connectors that are compatible with conductor material.
- T. Voltage Drop: All feeders on the project have been sized to limit voltage drop to 2% or less. It shall be the Contractor's responsibility to size branch circuits as necessary, based on their actual lengths, to limit branch circuit voltage drop to 3% or less. This will limit the overall voltage drop at each outlet to the 5% maximum allowed by the National Electrical Code.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Identify wire and cable under provisions of Section 260553.

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- B. Identify each conductor with its circuit number or other designation indicated on Drawings.

3.6 FIELD QUALITY CONTROL

- A. Perform field inspection and testing. Provide a written report of all test results to the Engineer.
- B. Inspect wire and cable for physical damage and proper connection. Replace all conductors and cables with damaged, insulation, sheaths, or jackets.
- C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- D. Verify continuity of each branch circuit conductor. Provide a written report of all test results to the Engineer.

END OF SECTION 260519

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SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Grounding Electrodes and Conductors
- B. Equipment Grounding Conductors
- C. Bonding

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NPFA 99 - Health Care Facilities
- C. NETA-ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (International Electrical Testing Association)

1.3 GROUNDING ELECTRODE SYSTEM

- A. Metal underground water pipe if present
- B. Metal frame of the building
- C. Rod electrode
- D. Reinforcing steel in foundation footing when being installed

1.4 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 5 ohms for equipment operation at 601 volts or higher, 25 ohms for equipment operating at 600 volts or less.

1.5 SUBMITTALS FOR REVIEW

- A. Submit a letter on Company letterhead stating that all equipment will be in compliance with the specifications.
- B. Test Report: Indicate overall resistance to ground.

1.6 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Accurately record actual locations of grounding electrodes.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

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1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Provide products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.9 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 ROD ELECTRODE

- A. Material: Copper-clad steel.
- B. Diameter: 3/4"
- C. Length: 10'

2.2 MECHANICAL CONNECTORS

- A. Material: Bronze.

2.3 EXOTHERMIC CONNECTIONS

- A. Material: Copper alloy or copper

2.4 WIRE

- A. Material: Stranded copper.
- B. Foundation Electrodes: 2/0 AWG.
- C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

- A. Grounding counterpoise: Grounding counterpoise shall consist of three (3) ground rods spaced 8' minimum on center. Rods shall be installed with top of rod 12" below finished grade. Rods shall be interconnected with a #4/0 bare copper electrode with cadweld connections at each ground rod. Provide dedicated 2" conduit for #4/0 bare copper electrode conductor to switchgear ground bus. Locate grounding electrode in a grassy area as close to the building as possible.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

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- C. Bonding Straps and Jumpers: install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- D. Metal Water Service Pipe: Provide insulated copper grounding conductor in 2" conduit from the electrical main service entrance equipment grounding bus to the main metal water service entrances to building. Connect ground bonding conductors to main metal water service pipes by grounding clamp connectors where a dielectric main water fitting is installed, connect ground bonding conductor to street side of fitting. Bond grounding conductor to conduit or sleeve at each end.
- E. Generator Grounding: Provide generator ground per manufacturer and National Electric Code.
- F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
- H. Install Products in accordance with manufacturer's instructions.
- I. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.
- J. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing.
- K. Provide bonding to meet Regulatory Requirements.
- L. Provide a grounding bushing and equipment grounding conductor on the terminal end of metallic conduit systems where any of the following conditions occur:
 - 1. A conduit carrying circuit conductors protected by an overcurrent device rated 50 amps or larger is connected to a metallic enclosure by concentric knockouts or reducing washers.
 - 2. Concentric knockout rings or bridges are broken.
 - 3. The enclosure is non-metallic and does not have an integral grounding strap.
 - 4. Conduits stub up through floors and foundations into switchboards, transformers, and other equipment without a metallic wall at the point of entrance.
- M. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus or bushing or terminal.

3.3 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. All underground bonding connections shall be exothermic-welded connections.

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- D. Equipment Grounding Conductor Terminations: For #8 AWG and larger, use pressure-type grounding lugs. #10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- F. Tighten screws and bolts for grounding and bonding 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.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- H. Moisture Protection. If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connections and seal against moisture penetration of insulation and cable.
- I. Provide #8 ground wire in ¾" conduit and connect flammable storage cabinets and acid storage cabinets to building steel. Verify and adjust ground wire size to match manufacturers recommended wire size.
- J. Wire Rod Type Cable Tray (Section 260536): Provide #2 bare copper conductor, entire length of cable tray. Bond at 50' intervals.
- K. Identification: Provide tag on each ground conductor at bus to read as follows: "Caution – Ground Wire – Do not Remove". Provide I.D. marking of all conductors as per N.E.C.

3.4 FIELD QUALITY CONTROL

- A. Perform NETA-ATS testing and inspection of the grounding and bonding system.
- B. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- C. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method. Provide a report of the results of the test of each grounding system. Where several grounding systems are tied together, test each system separately before making the interconnection.

END OF SECTION 260526

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SECTION 260529 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit and Equipment Supports
- B. Anchors and Fasteners
- C. Cable Supports

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NECA - National Electrical Contractors Association

1.3 SUBMITTALS FOR REVIEW

- A. Submit a letter on Company letterhead stating that all equipment will be in compliance with the specifications.

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.5 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide supporting devices which comply with manufacturer's standard materials, design, and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is installer's option.

2.2 ANCHORS

- A. Provide anchors of types, sizes and materials indicated, with the following construction features:
 - 1. Toggle Bolts: Springhead; 3/16" x 4".
 - 2. Expansion sleeve anchors by Hilti or Phillips Redhead: 2"

2.3 SLEEVES AND SEALS

- A. Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:

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1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
2. Fire-Rated Walls and Floors: At all locations where conduits or cables penetrate a fire-rated wall or floor, provide firestopping in accordance with Division 7.

2.4 U-CHANNEL STRUT SYSTEMS

- A. Provide U-Channel strut system for supporting equipment supplied under this contract, 12-ga hot-dip galvanized steel, or types and sizes indicated with standard green finish, and with the fittings which mate and match with U-Channel.
- B. Auxiliary Steel Supports: Provide all required auxiliary steel to install any equipment supplied under this contract. The design and gauge of steel used shall be as required by the manufacturer's specifications.

2.5 NON-CONTINUOUS CABLE SUPPORTS (J-HOOKS)

- A. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables.
- B. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
- C. Non-continuous cable supports 1-15/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger.
- D. Non-continuous cable supports shall have an electro-galvanized finish and be rated for indoor use in non-corrosive environments.
- E. Non-continuous cable supports shall be UL listed, with manufacturer's name and part number stamped on.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- C. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure as required. Do not use spring steel clips and clamps.
- D. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- E. Do not fasten supports to piping, ductwork, mechanical equipment, and conduit.
- F. Do not use powder-actuated anchors.
- G. Obtain permission from Architect before drilling or cutting structural members.
- H. Fabricate supports from structural steel or steel channel, rigidly welded, or bolted to present neat appearance with adequate strength and rigidity. Use hexagon head bolts with spring lock washers under all nuts.
- I. Install surface-mounted cabinets, enclosures, and panelboards with minimum of four anchors.

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- J. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1" off wall.
- K. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- L. Square cut and deburr all structural steel, strut, threaded rods, and similar items.
- M. Prime and paint all ferrous metals which are not factory finished.
- N. Strut and Hardware Finishes:
 - 1. Indoor dry locations: painted or pre-galvanized.
 - 2. Outdoor and indoor wet locations: post-galvanized.
 - 3. Corrosive locations: PVC coated or fiber reinforced plastic.
 - 4. Pool Environment: aluminum or stainless steel.
- O. Coordinate with other mechanical, plumbing, sprinkler, and electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- P. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports in compliance with NEC requirements.
- Q. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.
- R. Remove burrs from ends of pipe sleeves.
- S. Do not use bridle rings or tie-wraps to support cables. J-hooks are the only acceptable support method.

END OF SECTION 260529

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SECTION 260533 – RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metal Conduit
- B. Flexible Metal Conduit
- C. Liquidtight Flexible Metal Conduit
- D. Electrical Metallic Tubing
- E. Nonmetallic Conduit
- F. Fittings and Conduit Bodies
- G. Wireways
- H. Boxes
- I. Cabinets
- J. Enclosures

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated
- C. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated
- D. ANSI C80.6 – Intermediate Metal Conduit, Zinc Coated
- E. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
- F. NECA “Standard of Installation”
- G. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
- H. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
- I. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing
- J. NEMA TC 12 - Corrugated Polyvinyl Chloride Coilable Plastic Utilities Duct
- K. UL 94 - Vertical Flame Test
- L. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies
- M. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports

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- N. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes
- O. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- 1.3 DESIGN REQUIREMENTS
 - A. Conduit Size: ANSI/NFPA 70.
- 1.4 QUALITY ASSURANCE
 - A. Fire rated pathways shall bear the UL Classification marking.
 - B. Pathways shall be tested in accordance with ASTM E814 (ANSI/UL1479)
- 1.5 SUBMITTALS FOR REVIEW
 - A. Submit a letter on Company letterhead stating that all equipment will be in compliance with the specifications.
- 1.6 SUBMITTALS FOR CLOSEOUT
 - A. Submit under provisions of Section 260010.
 - B. Accurately record actual routing of conduits larger than 1" which are installed underground or under a slab on grade.
- 1.7 REGULATORY REQUIREMENTS
 - A. Conform to requirements of ANSI/NFPA 70.
 - B. Furnish products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.
- 1.8 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver, store, protect, and handle Products to site under provisions of Section 260010.
 - B. Accept conduit on site. Inspect for damage.
 - C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
 - D. Protect non-metallic conduit from sunlight.
- 1.9 PROJECT CONDITIONS
 - A. Verify that field measurements are as shown on Drawings.
 - B. Verify routing and termination locations of conduit prior to rough-in.
 - C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

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1.10 WARRANTY

- A. Provide the warranty specified in section 260010.

PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS

- A. Minimum Size: 3/4" unless otherwise specified.
- B. Where control devices are provided with 1/2" knockouts or hubs, 3/8" or 1/2" flexible conduit not exceeding 3' in length may be installed between the device and a junction box or conduit fitting.
- C. Underground Installations: Use galvanized rigid steel conduit or nonmetallic conduit as indicated.
 - 1. Minimum Size: 1"
- D. Outdoor Locations, Above Grade: Use galvanized rigid steel conduit or intermediate metal conduit.
- E. Outdoor Locations, Below Grade: Use nonmetallic conduit, concrete encased or stone-dust encased per details on drawings. All elbows shall be long radius steel.
- F. Wet and Damp Locations: Use galvanized rigid steel or intermediate metal conduit.
- G. Dry Locations:
 - 1. Concealed: Use galvanized rigid steel, intermediate metal conduit or electrical metallic tubing.
 - 2. Exposed: Use galvanized rigid steel, intermediate metal conduit or electrical metallic tubing.

2.2 METAL CONDUIT

- A. Galvanized Rigid Steel Conduit (GRC): ANSI C80.1.
- B. Intermediate Metal Conduit (IMC): Rigid steel.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit.

2.3 FLEXIBLE METAL CONDUIT

- A. Description: Interlocked steel construction.
- B. Fittings: ANSI/NEMA FB 1.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Description: Interlocked steel construction with PVC jacket.
- B. Fittings: ANSI/NEMA FB 1.

2.5 ELECTRICAL METALLIC TUBING (EMT)

- A. Description: ANSI C80.3; galvanized tubing.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel or malleable iron, compression type. Indenter type may be substituted for 3/4" size tubing installed in dry locations.

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2.6 NONMETALLIC CONDUIT

- A. Description: NEMA TC 2; Schedule 40 PVC.
- B. Fittings and Conduit Bodies: NEMA TC 3.

2.7 WIREWAY

- A. Description:
 - 1. Indoor Use: General Purpose
 - 2. Where Indicated: Oil-tight and Dust-tight
 - 3. Outdoor Use: Rain-tight
- B. Knockouts: Manufacturer's Standard
- C. Size: Size and length as indicated or required for installation.
- D. Cover: Hinged or screw covers. Provide full gasketing on oil-tight wireways.
- E. Connector: Slip-in or flanged.
- F. Fittings: Lay-in type with removable top, bottom, and sides.
- G. Finish: Rust inhibiting primer coating with gray enamel finish or pre-galvanized.

2.8 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Shape and size shall suit the type of fixture or canopy and be rated for weight of equipment supported; include 1/2" male fixture studs where required.
 - 2. Minimum Depth – 2-1/8"
 - 3. Concrete Ceiling Boxes: Concrete type.
 - 4. Provide 4" square boxes for fire alarm signaling devices and similar devices.
- B. Nonmetallic Outlet Boxes: NEMA OS 2.
- C. Cast Boxes: NEMA FB 1, Type FD, aluminum or cast ferrous alloy. Provide gasketed cover by box manufacturer. Provide boxes with threaded hubs.
- D. Use cast outlet boxes in exterior and wet locations.

2.9 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
 - 1. Cover: Furnish with machine screws.
- B. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 - 1. Material: Galvanized cast iron or Cast aluminum.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless-steel cover screws.

2.10 HINGED COVER ENCLOSURES

- A. Manufacturers:
 - 1. Square D
 - 2. Hoffman Engineering
 - 3. Hammond Manufacturing

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- B. Construction: NEMA 250, galvanized steel.
- C. Covers: Continuous hinge, held closed by perimeter clamps operated by screws.
- D. Provide interior metal panel for mounting terminal blocks and electrical components finish with white enamel.
- E. Enclosure Finish: Manufacturer's standard enamel.
- F. Provide accessory feet for free standing enclosures.
- G. Enclosure:
 - 1. Interior Dry Locations: Type 1
 - 2. Interior Wet Locations: Type 4
 - 3. Exterior Locations: Type 3R
 - 4. Kitchen: Stainless Steel
 - 5. Dishwashing Rooms/Areas: Stainless Steel

2.11 CABINETS

- A. Manufacturers:
 - 1. Square D Company
 - 2. Hoffman Engineering
 - 3. Hennesy Enclosures
- B. Boxes: Galvanized Steel
- C. Box Size: As indicated or as required to house the indicated quantity of cables and connections plus 20% spare.
- D. Backboard: Provide 3/4" thick plywood backboard for mounting terminal blocks. Paint matte white.
- E. Fronts: Steel, flush or surface type as indicated with concealed trim clamps, concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.
- F. Knockouts: As required.
- G. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring.
- H. Provide accessory feet for free standing equipment.
- I. Enclosure:
 - 1. Interior Dry Locations: Type 1
 - 2. Interior Wet Locations: Type 4
 - 3. Exterior Locations: Type 3R
 - 4. Kitchen: Stainless Steel
 - 5. Dishwashing Rooms/Areas: Stainless Steel

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify locations of floor boxes and outlets prior to rough-in.

3.2 CONDUIT INSTALLATION

- A. Install conduit in accordance with NECA "Standard of Installation" except paragraphs on "Mounting Height".

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- B. Install nonmetallic conduit in accordance with manufacturer's instructions.
- C. Arrange supports to prevent misalignment during wiring installation.
- D. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- E. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25% additional conduits.
- F. Fasten conduit supports to building structure and surfaces under provisions of Section 260010.
- G. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports
- H. Do not attach conduit to suspended ceiling support wires.
- I. Arrange conduit to maintain headroom and present neat appearance.
- J. Route conduit parallel and perpendicular to walls.
- K. Route conduit installed above accessible ceilings parallel and perpendicular to walls.
- L. Route conduit in stone/gravel fill under slab from point-to-point.
- M. NO CONDUIT SHALL BE INSTALLED VERTICALLY OR HORIZONTALLY IN MASONRY CAVITIES. Penetrations through the cavity are permitted for items such as electrical fixtures and devices, etc. but they shall be horizontal, perpendicular through the cavity, and located directly at the intended item.
- N. In new construction, unless specifically specified otherwise or approved in writing in advance by Architect, NO exposed conduit will be acceptable in finished spaces.
- O. In underslab branch circuit raceways, there should be no less than one raceway extension installed from electrical device to an above accessible ceiling location terminated in a junction box per room. The intent of this requirement is to give future access to this raceway and circuits.
- P. Provide raceways for all low voltage wiring in open structure ceiling spaces.
- Q. Maintain adequate clearance between conduit and piping.
- R. Maintain 12" clearance between conduit and surfaces with temperatures exceeding 104°F.
- S. Cut conduit square using saw or pipe-cutter; de-burr cut ends.
- T. Bring conduit to shoulder of fittings; fasten securely.
- U. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- V. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- W. Install no more than equivalent of three 90° bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2".
- X. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

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- Y. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and expansion joints.
- Z. Provide suitable pull string in each empty conduit except sleeves and nipples.
- AA. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- BB. Ground and bond conduit and wireways under provisions of Section 260526.
- CC. Identify conduit under provisions of Section 260553.
- DD. Do not install conduits in the topping on precast floor and roof planks and tees.
- EE. Wireway Supports: provide steel channel supports as required or indicated. Mount directly on suitable walls and structural elements.
- FF. Close ends of wireway.
- GG. Throughout new installation, all raceways and boxes shall be installed so that they are concealed in new construction. Any exceptions shall be approved by Architect before installation.

3.3 BOX INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA "Standard of Installation" except for mounting heights.
- C. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- D. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- E. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box location up to 10' if required to accommodate intended purpose.
- F. Orient boxes to accommodate wiring devices oriented as specified in Section 262726.
- G. Maintain headroom and present neat mechanical appearance.
- H. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- I. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6" from ceiling access panel or from removable recessed luminaire.
- J. All raceway/wiring and outlet box installations shall be installed as needed to meet the Architect's Ceiling, Wall, and Floor ratings. Review with Division 7 and Architect as needed to maintain the established and existing Ceiling, Wall, and Floor Ratings.
- K. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes and beside lavatory partitions, mirrors, lavatory fixtures and changes in architectural finishes.
- L. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- M. Align adjacent wall mounted outlet boxes which are indicated to be mounted at the same height.
- N. Use flush mounting outlet box in finished areas.

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- O. Install outlet boxes even with top and bottom of masonry course. Boxes shall be installed flush with no back to back outlet box installations between rooms/areas. Installations shall be coordinated with the GC/Masonry Contractor as needed. Any installation requiring an outlet box rough-in that does not line up with masonry course shall be reviewed with Architect/Engineer before installing.
- P. Outlet boxes shall not be installed back to back between rooms/areas. Provide a minimum of one stud opening space between outlet boxes installed on opposite sides of walls as needed to meet the acoustical and fire rating requirements. Where wall space is limited, and room layout or equipment requires outlet rough-ins to be installed at a closer dimension, review with Architect/Engineer before installing.
- Q. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- R. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- S. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- T. Use adjustable steel channel fasteners for hung ceiling outlet box.
- U. Do not fasten boxes to ceiling support wires.
- V. Support boxes independently of conduit.
- W. Use gang box where more than one device is mounted together. Do not use sectional box.
- X. Use gang box with plaster ring for single device outlets.
- Y. Use cast outlet box in exterior locations and wet locations.
- Z. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.
- AA. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.
- BB. Install cabinet fronts plumb.
- CC. Do not drill or punch cabinets and enclosures except where devices or hardware which have the same NEMA type rating are being installed.
- DD. Mount waterproof enclosures using the holes or brackets furnished by the manufacturer only.
- EE. Provide enclosures for all control devices, pilot devices, timers, starters, contactors, adjustable frequency drives and programmable logic controller.
- FF. Provide cabinets where indicated or as required.
- GG. Throughout new installation, all raceways and boxes shall be installed so that they are concealed in new construction. Any exceptions shall be approved by Architect before installation.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods under the provisions of Division 7.
- B. Route conduit through roof, wall, floor and ceiling openings and repair as specified in Section 260010.
- C. Low Voltage Wiring: Provide raceways for all wiring in all open structure ceiling spaces.

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- D. Indoor Dry Type Transformers: Provide flexible conduits not exceeding 3' in length between the transformer enclosure and the end of all rigid conduits and non-flexible tubing. The flexible conduit shall be installed with a minimum 45° bend in its length.
- E. Motors: Provide flexible conduit not exceeding 4' in length between the motor junction box and the end of all rigid conduit and non-flexible tubing. Provide sufficient slack to permit the motor to be moved over the entire range of adjustment in the motor base and sub-base without stressing the flexible conduit or its connectors.
- F. Other Adjustable Devices: Provide flexible conduit at any device which has electrical connections and is adjusted for proper operation by sliding or rotating the mounting of the device. Provide flexible conduit of sufficient length to permit the full range of adjustment allowed by the device mounting.
- G. Prewired Furniture: provide liquid-tight metal conduit not exceeding 4' in length between floor/wall box and furniture connection point for power and telecommunications.
- H. At HVAC equipment on trapeze hangers or vibration isolators, provide sufficient length of flexible conduit to accommodate the full range of normal motion without stressing the conduit or transmitting excessive mechanical forces to rigidly mounted conduit or building structures. Install the flexible conduit in such a manner that a 90° bend is included in the length of flexible conduit.
- I. Provide flexible conduits that are of sufficient length so they allow the full range of movement for adjustment and vibration without stressing the flexible conduit or connectors.
- J. Coordinate installation of outlet box for equipment connected under Section 260180.
- K. Throughout new installation, all raceways and boxes shall be installed so that they are concealed in new construction. Any exceptions shall be approved by Architect before installation.

3.5 INTERFACE WITH CONCRETE SLABS

- A. Conduits are not permitted in concrete slabs or elevated slabs for this project.
- B. Concrete Floors on Grade: Install conduits under concrete slabs in stone base.
- C. Concrete Elevated Floors: Install conduits below slab in ceiling plenum of floor below.
- D. Review all underslab conduit interface with Architect/Engineer before installation.

3.6 ADJUSTING

- A. Test, adjust, and balance as required.
- B. Adjust floor box flush with finish flooring material.
- C. Adjust flush-mounting outlets to make front flush with finished wall material.
- D. Install knockout closures in unused box openings.

3.7 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

END OF SECTION 260533

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SECTION 260534 – SURFACE RACEWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A.** Surface Metal Raceways
- B.** Surface Metal Multi-Outlet Systems

1.2 SURFACE RACEWAY REQUIREMENTS

- A.** All raceways and boxes to be recessed in existing walls where walls are fishable. Any exceptions to be approved by the Architect/Engineer before installation
- B.** Surface raceway may only be used when walls are not fishable.
- C.** Throughout new installations, all raceways, and boxes to be concealed in the new construction.

1.3 REFERENCES

- A.** ANSI/NFPA 70 - National Electrical Code
- B.** NECA (National Electrical Contractors Association) Standard of Installation.
- C.** NEMA WD 6 - Wiring Device Configurations.

1.4 SUBMITTALS FOR REVIEW

- A.** Submit under provisions of Section 260010.
- B.** Shop Drawings: The following items shall be submitted for review and approval:
 - 1.** Submittal booklet to include the following:
 - a.** Reference to Specification Section.
 - b.** A list of all equipment to be provided and installed.
 - c.** Data sheets to indicate specific items or model numbers highlighted.
 - d.** Manufacturers' installation instructions.

1.5 QUALITY ASSURANCE

- A.** Perform Work in accordance with NECA Standard of Installation except for mounting heights.
- B.** Maintain one copy of document on site.

1.6 QUALIFICATIONS

- A.** Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

- A.** Conform to requirements of ANSI/NFPA 70.

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- B. Furnish products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.8 WARRANTY

- A. Provide the warranty specified in section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. The Wiremold Company
- B. Hubbell

2.2 SURFACE METAL RACEWAY (700 Series) (HBL750 Series)

- A. Materials: The raceway and all system components must be UL Listed. They shall be manufactured of steel; zinc plated, galvanized, and/or finished in white "ScuffCoat" (a polyester topcoat over white base) and shall be suitable for field repainting to match surroundings.
- B. Raceway: The raceway shall be a one-piece design with a base and cover factory assembled. Total width shall be a minimum 0.75" by 0.66" deep with a cross sectional area of 0.25 square inches. The raceway base and cover shall have an approximate thickness of .040". The raceway shall be available in 5' and 10' lengths. A hand operated cutting tool shall be available for the base and cover to ensure clean, square cuts.
- C. Fittings: A full complement of fittings shall be available including but not limited to mounting clips and straps, couplings, flat, internal, and external elbows, cover clips, tees, entrance fittings, conduit connectors and bushings. The covers shall be painted with an enamel finish, in white color to match the raceway. They shall overlap the raceway to hide uneven cuts. All fittings shall be supplied with a base where applicable.
- D. Device and Fixture Boxes: Device boxes shall be available for mounting standard devices and faceplates. A device box shall be available in single and multiple gang configurations up to six-gang. They shall range in depth from 0.94" to 2.75". Single-gang boxes shall allow for snap-on and fastener application. Extension boxes shall be available to adapt to existing standard flush switch and receptacle boxes. All device and fixture box covers shall be painted with an enamel finish, white in color to match the raceway cover.
- E. Communication Devices and Accessories: The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP/STP Fiber Optic, Coaxial and other cabling types with face plates and bezels to facilitate mounting. A complete line of preprinted station and port identification labels, snap-in icon buttons as well as write-on station identification labels shall be available.

2.3 SURFACE METAL RACEWAY (2400BD Series) (HBL2400BDIV Series)

- A. Materials: The raceway and all system components must be US/C Listed. The base and cover shall be manufactured of steel, finish in white ScuffCoat (a polyester topcoat over white base) or custom colors and suitable for field repainting.
- B. Raceway: The raceway shall be a two-piece design with a base divided into two compartments of 1/3 and 2/3 the width of raceway base and snap-on-cover. Total width shall be 1.90" x 0.88" deep with a cross sectional area of 0.374 square inches for the 1/3 compartment and 0.666 square inches for the 2/3 compartment. The base and cover shall be a minimum thickness of 0.040". The raceway base shall be available in 10' lengths and the cover shall be available in 5' lengths.
- C. Fittings: A full complement of fittings must be available including, but not limited to, couplings, flat, internal, and external elbows, entrance end fittings, blank end fittings, cover clips and wire clips. The fitting covers shall be manufactured of steel and be painted with an enamel finish or a rigid plastic compound that exhibits

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nonflammable self-extinguishing characteristics tested to comparable specifications of UL94V-0. All fittings shall be supplied with a base where applicable.

- D. Device and Extension Boxes: Device boxes shall be available to mount standard devices and activate inserts with faceplates in single and two gang configurations. Device bases shall be available for over-the-raceway mounting feature with twist-outs that allow for access into either raceway compartment. The boxes shall be available in 2-3/4" depth and painted to match the raceway.
- E. Communication Devices and Accessories: The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP/STP, Fiber Optic, Coaxial and other cabling types with faceplates and bezels to facilitate mounting. A complete line preprinted station and port identification labels, snap-in-icon buttons as well as write-on station identification labels shall be available.

2.4 SURFACE METAL RACEWAY (4000 Series) (DS4000 Series) (HBL4750 Series)

- A. Materials: The raceway and all system components must be UL Listed. Steel shall be galvanized. Finish shall be gray, white, or custom colored and be suitable for field repainting to match surroundings.
- B. Raceway: The raceway shall be a two-piece design with a metal base and a snap-on metal cover. The base shall be a minimum of 0.050" wall thickness and the cover a minimum of 0.040" wall thickness. Assembled base and cover shall be a minimum 4.75" wide by 1.75" high with a cross sectional area of 15.82 square inches. The base shall be dividable into two equal compartments; or two compartments representing a 1/3 and 2/3 split; or three equal compartments by means of a removable barrier. A hand-operated cutting tool shall be available for the cover to ensure clean, square cuts.
- C. Fittings: A full complement of fittings must be available including, but not limited to flat, internal, and external elbows, entrance fittings, wire clips, cover clips, couplings, c-hangers, and end caps. The fittings shall be colored to match the raceway. All fittings shall be supplied with a base where applicable to eliminate mitering.
- D. Device Brackets and Plates: Device brackets shall be available for mounting one or two-gang devices either horizontally or vertically within the raceway. Devices, both power and data/communication shall have the capacity of mounting flush or in conjunction with standard faceplates.
- E. Plastic Overlapping Cover Bracket and Faceplates: A plastic device mounting bracket and trim plate shall be available to install devices horizontally. Trim plate shall overlap cover – eliminating seam. Faceplates shall be available to accept a variety of power and data/communication devices. Plastic material must be compatible with UL94 for plastic materials.

2.5 SURFACE METAL MULTI-OUTLET SYSTEM (20GB Series) (HB20GB Series)

- A. Materials: The raceway and all system components must be UL Listed. They shall be manufactured of steel; zinc plated, galvanized, and/or finished in white "ScuffCoat" (a polyester topcoat over white base) and shall be suitable for field repainting to match surroundings.
- B. Raceway: The raceway shall be a two-piece design with a base and cover factory assembled. Total width shall be a minimum 1.28" by 0.75" deep. The raceway base and cover shall have an approximate thickness of .040". The raceway shall be available in 3', 5' and 10' lengths. A hand operated cutting tool shall be available for the base and cover to ensure clean, square cuts.
- C. Fittings: A full complement of fittings shall be available including but not limited to mounting clips and straps, couplings, flat, internal, and external elbows, cover clips, tees, entrance fittings, conduit connectors and bushings. The covers shall be painted with an enamel finish, in white color to match the raceway. They shall overlap the raceway to hide uneven cuts. All fittings shall be supplied with a base where applicable.
- D. Devices: Provide 20-amp, single-circuit pre-wired raceway with simplex receptacles spaced 1' O.C.

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PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Use flat-head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level.
- C. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- D. Close ends of unused raceway openings.
- E. Ground and bond raceway under provisions of Section 260526.
- F. Do not use adhesive alone where non-metallic raceway is used.

END OF SECTION 260534

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SECTION 260543 – UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit
- B. Duct
- C. Metallic Warning Tape
- D. Innerduct
- E. Handholes

1.2 RELATED WORK/DIVISIONS

- A. Division 3
- B. Division 31

1.3 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. AASHTO H-20 - Standard Specification for Highway Bridges
- C. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
- D. ANSI/ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware
- E. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality
- F. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
- G. ANSI/NFPA 70 - National Electrical Code
- H. ASTM A48 - Gray Iron Castings
- I. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips
- J. Bellcore TR-TSY 000356 - Optical Cable Duct Liner
- K. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
- L. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing
- M. NEMA TC 6 - PVC and ABS Plastic Utilities Duct for Underground Installation
- N. NEMA TC 8 - Extra-Strength PVC Plastic Utilities Duct for Underground Installation

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- O. NEMA TC 9 - Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation
- P. NEMA TC 10 - PVC and ABS Plastic Communications Duct and Fittings for Underground Installation
- Q. NEMA TC 14 - Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings
- R. PENNDOT 408: Pennsylvania Department of Transportation Form 408 Specification
- S. CMTI – Construction Materials Testing Institute

1.4 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate dimensions, capacities, reinforcement, size, location of openings and accessories.
 - d. Submit manufacturer's certificates on conduit and ducts.
 - e. Submit Utility Company approval letter for transformer foundation.
 - f. Submit Utility Company approval letter for manhole/handholes used in electrical duct system.
 - g. Submit metallic underground warning tape.

1.5 SUBMITTAL FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Accurately record actual locations of exact routing of ductbank.
- C. Accurately record actual locations of each manhole, handhole, and transformer vault.
- D. Provide maintenance materials.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.
- B. Manholes, handholes and transformer vault must meet Utility Company requirements.

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle Products to site under provisions of Section 260010.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

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1.9 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of duct bank prior to excavation for rough-in.
- C. Verify locations of access structures prior to excavating for installation.
- D. Duct bank routing is shown on Drawings in approximate locations unless dimensions are indicated. Route as required to complete duct system.
- E. Access structure's locations are shown on Drawings in approximate locations unless dimensions are indicated. Locate as required to complete ductbank system.

1.10 MAINTENANCE MATERIALS

- A. Provide 2 of each special tool required for maintenance.

1.11 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 RIGID METAL CONDUIT

- A. Rigid Steel Conduit: ANSI C80.1.
- B. Fittings: ANSI/NEMA FB 1; steel.

2.2 PLASTIC CONDUIT

- A. Description: NEMA TC 2; Schedule 40 PVC.
- B. Fittings and Conduit Bodies: NEMA TC 3.

2.3 RIGID INNERDUCT

- A. All innerduct must meet or exceed requirements of NEC, Section 770 and 800.
- B. All innerduct must be UL listed.
- C. All innerduct must be HDPE corrugated innerduct for outdoor use.
- D. All innerduct must have pre-installed pull line in all sizes.
- E. Innerducts used in the same conduit shall be different continuous colors.
- F. All innerduct shall be available in 1", 1.5" and 2" sizes. Use sizes as indicated or required for cables.

2.4 HANDHOLES

- A. Material: Glass Fiber reinforced polymer concrete. UL Listed.

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- B. Construction: Modular sections. Bottom of box shall be open.
- C. Size: 18" x 18" x 18" unless otherwise indicated or required.
- D. Loading:
 - 1. Grassy areas subject to occasional nondeliberate heavy vehicular traffic: Tier 22.
 - 2. Driveways, parking lots, and other paved areas subject to heavy vehicular traffic: AASHTO H-20.
- E. Cover: Heavy duty gasketed, minimum coefficient of friction of 0.5.
- F. Logo: Provide cover marked to indicate usage, (Electric, Telecommunications or Site Lighting).
- G. Color: Green or to match surrounding surface. (Verify with Architect)
- H. Hardware: Stainless steel penta-head bolt. Provide two (2) penta-head sockets to Owner.

2.5 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for 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. Inscriptions for Red-Colored Tapes: ELECTRIC LINE HIGH VOLTAGE
 - 2. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE
- C. Type:
 - 1. Detectable, 3-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - 2. Overall Thickness: 5 mils
 - 3. Foil Core Thickness: 0.35 mils
 - 4. Weight: 28 lb/1000 sqft
 - 5. 3" Tensile according to ASTM D 882: 70 lbf, and 4600 psi

2.6 MATERIALS FOR ENCASEMENT

- A. Provide concrete for encasement of duct banks under the provisions of Division 3 with a minimum compressive strength of 2500 psi and a maximum slump of 4". Plasticizers to increase the slump to 6" may be added after the unmodified slump has been verified. Maximum aggregate size 3/8".
- B. Stonedust

2.7 FLOWABLE FILL

- A. Provide flowable fill containing, at a minimum, cementitious materials, and water. Cementitious materials shall be Portland cement, pozzolanic materials, or other self-cementing materials, or combinations thereof, at the contractor's option, and following approval by the Architect/Engineer. The flowable fill mix design may also contain, fine aggregate or filler, and/or chemical admixtures in any proportions such that the final product meets the strength, flow consistency and shrinkage requirements included in this specification, as approved by the Architect/Engineer.
- B. Portland Cement: ASTM C150, Type 1 or Type 2, meeting PADOT standards.

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- C. Mixing Water: Fresh, clean, and potable, PADOT standards for use as mix-water for cast-in-place concrete.
- D. Air-Entraining Admixture: ASTM C260.
- E. Chemical Admixtures: ASTM C494.
- F. Aggregate: ASTM C33.

2.8 FLOWABLE FILL MIXTURE:

- A. Mix design shall produce a consistency that will result in a flowable product at the time of placement which does not require manual means to move it into place.
- B. Excavatable Flowable Fill:
 - 1. Type 1 Portland Cement: 50-100 lbs/cy
 - 2. Fly Ash: 250-600 lbs/cy
 - 3. Air: 15-35%
 - 4. Unit Weight, wet: 90-100 lbs/cf
 - 5. Unit Weight, wet: 100- 125 lbs/cf
 - 6. Water: Mix water as necessary to produce a consistency that will result in a flowable, self-leveling product at the time of placement.
 - 7. 28 Day compressive strength: 150psi max
- C. Non- Excavatable Flowable Fill:
 - 1. Type 1 Portland Cement: 75-150 lbs/cy
 - 2. Fly Ash: 150-600 lbs/cy
 - 3. Air: 5-20%
 - 4. Unit Weight, wet: 100- 125 lbs/cf
 - 5. Water: Mix water as necessary to produce a consistency that will result in a flowable, self-leveling product at the time of placement.
 - 6. 28 Day compressive strength: 150 psi minimum
- D. Provide equipment as recommended by the Manufacturer and comply with manufacturer's recommendations for the addition of additives, whether at the production plant or prior to placement at the site.

2.9 REINFORCING FOR CONCRETE ENCASEMENT

- A. #4 rods on all four corners of the envelope and #4 tie rods every 4' with necessary ties.

2.10 AGGREGATE

- A. For bedding of precast structures: PENNDOT 408: Number 1B.
- B. For Spill Containment: PENNDOT 408: Number 3.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify excavation under provisions of Division 31.
- B. Verify that excavation, base material installation, and compaction is completed.

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3.2 PREPARATION

- A. Excavate, install base material, and compact base material in accordance with handhole manufacturer's instructions.

3.3 DUCT BANK INSTALLATION

- A. Provide concrete encasement for telecommunications and site lighting ductbanks only under paved areas. Provide stonedust encasement for all non-paved areas unless otherwise noted.
- B. Install duct to locate top of ductbank at depths as indicated on drawings, NEC and as required by project conditions.
- C. Install duct with minimum slope of 4" per 100'. Slope duct away from building entrances.
- D. Cut duct square using saw or pipe cutter; de-burr cut ends.
- E. Insert duct to shoulder of fittings; fasten securely.
- F. Join nonmetallic duct using adhesive as recommended by manufacturer.
- G. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- H. Install no more than equivalent of three 90° bends between pull points.
- I. Provide suitable fittings to accommodate expansion and deflection where required.
- J. Terminate duct at manhole entries using end bell.
- K. Stagger duct joints vertically in concrete encasement 6" minimum.
- L. Use suitable separators and chairs installed not greater than 4' on centers for encased ductbanks.
- M. Securely anchor duct to prevent movement during concrete placement.
- N. Provide concrete under provisions of Division 3.
- O. Provide minimum 3" concrete cover at bottom, top, and sides of ductbank.
- P. Connect to existing concrete encasement using dowels.
- Q. Provide suitable pull string in each empty duct except sleeves and nipples.
- R. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- S. Provide backfill for all trenches under provisions of Division 31.
- T. Interface installation of underground warning tape with backfilling specified in Division 31.
- U. Provide bends in duct bank as necessary to allow conduits to enter access structures perpendicular to the structure wall.
- V. A minimum separation of 12" shall be maintained between telecommunication ductbanks and electrical ductbanks.

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3.4 UNDERGROUND-LINE WARNING TAPE INSTALLATION

- A. During backfilling of trenches install continuous underground-line warning tape directly above line at 6" to 8" below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16" overall.
- B. Provide number of tapes per trench as follows:
 - 1. Up to 18" wide: 1 tape in center of trench
 - 2. 18" to 36" wide: 2 tapes 18" apart
 - 3. 36" to 48" wide: 3 tapes 16" apart

3.5 FLOWABLE FILL INSTALLATION

- A. Place concrete via chute in flowable condition directly to cavity to be filled.
 - 1. To prevent segregation, drum should continuously agitate mix while on truck.
 - 2. Do not use vibrator to "pull" flowable fill
 - 3. Adjust mix as required to allow for pumping if delivery location requires.
- B. The flowable fill shall be left undisturbed until the material obtains sufficient strength. Sufficient strength for paving is achieved when the flowable fill can support the weight of foot traffic without apparent deformation.
- C. Protect exposed surfaces of flowable fill from premature drying, wash by rain or running water, wind, mechanical injury, and excessively hot or cold temperature.

3.6 HANDHOLE INSTALLATION

- A. Install handholes in accordance with manufacturer's instructions.
- B. Install handholes plumb.
- C. Provide all excavation, backfill and crushed stone base as required to install handhole.

3.7 CABLE INSTALLATION

- A. Support all cables on rack arms.
- B. Route cables so that they do not block access to other conduits, ladders, pulling irons, sump pumps or working space.

3.8 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Grounding System: Ground pad-mounted equipment and non-current-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes.

END OF SECTION 260543

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SECTION 260544 – SLEEVES & SLEEVE SEALS FOR ELECTRICAL RACEWAYS & CABLING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Sleeves
- B. Sleeve Seal Systems
- C. Grout
- D. Sealants
- E. Firestopping

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electric Code
- B. NFPA 101 – Life Safety Code
- C. Test Requirements: ASTM E 814, “Standard Method of Fire Tests of Through Penetration Fire Stops”
- D. Test Requirements: UL 1479, “Fire Tests of Through-Penetration Firestops”
- E. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their “FIRE RESISTANCE DIRECTORY” that is updated annually.
 - 1. UL Fire Resistance Directory:
 - a. Firestop Devices (XHJI)
 - b. Fire Resistance Ratings (BXRH)
 - c. Through-Penetration Firestop Systems (XHEZ)
 - d. Fill, Voids, or Cavity Material (XHHW)
 - e. Forming Materials (XHKU)
- F. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments
- G. Inspection Requirements: ASTM E 2174, “Standard Practice for On-site Inspection of Installed Fire Stops.”
- H. ASTM E 84, “Standard Test Method for Surface Burning Characteristics of Building Materials.”

1.3 QUALITY ASSURANCE

- A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.
- B. Firestop System installation must meet requirements of ASTM E 814 or UL 1479 tested assemblies that provide a fire rating equal to that of construction being penetrated.
- C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

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- D. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.
- E. For those firestop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

1.4 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. UL System drawings for each firestopping application.
 - d. Manufacturer's Certificates of Conformance for their products.
 - e. Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of UL firestop systems to be used and manufacturer's installation instructions to comply with this Section.
 - f. Manufacturer's engineering judgment identification number and drawing details when no UL system is available for an application. Engineering judgment must include both project name and contractor's name who will install firestop system as described in drawing.

1.5 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at jobsite.
- C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature limitations.
- D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- E. Do not use damaged or expired materials.

1.7 PROJECT CONDITIONS

- A. Do not use materials that contain flammable solvents.
- B. Scheduling:
 - 1. Schedule installation of CAST IN PLACE firestop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete.
 - 2. Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings.
- C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

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- D. Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.
- E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

1.8 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

- A. Wall Sleeves, Steel: Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.
- B. Wall Sleeves, Cast Iron: Description: Cast or fabricated "wall pipe", equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
- C. Pipe Sleeves, PVC: Description: ASTM D1785, Schedule 40.
- D. Molded Sleeves, PVC: Description: With nailing flange for attaching to wooden forms.
- E. Molded Sleeves, PE, or PP: Description: Removable, tapered cup-shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sheet Metal Sleeves, Galvanized Steel, Round: Description: Galvanized-steel sheet; thickness not less than 0.0239" round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

- A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:
 - 1. Description:
 - a. Material: Galvanized sheet steel.
 - b. Minimum Metal Thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50" and with no side larger than 16", thickness must be 0.052".
 - 2) For sleeve cross-section rectangle perimeter not less than 50" or with one or more sides larger than 16", thickness must be 0.138".

2.3 SLEEVE SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
 - 1. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel, Stainless steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

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1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.5 POURABLE SEALANTS

- A. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.6 FOAM SEALANTS

- A. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam. Foam expansion must not damage cables or crack penetrated structure.

2.7 FIRESTOPPING MANUFACTURERS

- A. Subject to compliance with through penetration firestop systems (XHEZ) listed in Volume II of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:
 1. Hilti Firestop Systems
 2. Specified Technologies Inc
 3. 3M Fire Protection Products
 4. Tremco, Inc
 5. Nelson Firestop Products
 6. USG Corporation

2.8 GENERAL FIRESTOPPING REQUIREMENTS

- A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
- B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- C. Penetrations in Fire Resistance Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
 1. F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.
- D. Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
 1. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
 2. T-Rating: when penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
 3. W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.
- E. Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.
- F. Mold Resistance: Provide penetration firestoppping with mold and mildew resistance rating of 0 as determined by ASTM G21.

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2.9 GENERAL FIRESTOPPING REQUIREMENTS

- A. Provide firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Firestop 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. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls, and fire partitions.
 - 2. 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 (2.49 Pa).
 - 1. Horizontal assemblies include floors and floor/ceiling assemblies.
 - 2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
 - 3. 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: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.
- E. 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

2.10 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.

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- 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 non-shrinking, 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, non-shrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants; pourable (self-leveling) grade formulation for openings in floors and other horizontal surfaces, and non-sag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of non-sag grade for both opening conditions.

2.11 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.

2.12 IDENTIFICATION

- A. Through-Penetration Firestop Systems: Adhesive labels with preprinted, flexible, self-adhesive vinyl with legend over-laminated with a clear weather and commercial resistant coating.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor, so no voids remain. Tool exposed surfaces smooth; protect material while curing.

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- b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants".
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4" annular clear space between sleeve and raceway or cable, unless sleeve seal system is to be installed or seismic criteria require different clearance.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2" above finished floor level. Install sleeves during erection of floors.
 - C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for wall assemblies.
 - 3. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
 - E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel, cast-iron pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1" annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - F. Underground, Exterior-Wall and Floor Penetrations:
 - 1. Install steel, cast-iron pipe sleeves with integral waterstops. Size sleeves to allow for 1" annular clear space between raceway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.
 - 2. Install steel pipe sleeves. Size sleeves to allow for 1" annular clear space between raceway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.
- 3.2 INSTALLATION OF SLEEVES FOR FIRE-RATED ELECTRICAL PENETRATIONS
- A. The Contractor shall be responsible for providing permanent, UL approved firestopping systems for all penetrations through fire rated floor or fire rated wall assemblies. For areas that will require future access for the installation of additional cables, repair, or retrofit, the firestopping system shall consist of re-usable intumescent pillows or putty. All firestopping shall meet the requirements of ASTM E-814 and UL 1479.
 - B. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory.
 - C. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration joint materials.
 - 1. Seal all holes or voids made by penetrations to ensure an air and water-resistant seal.
 - 2. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
 - 3. Protect materials from damage on surfaces subjected to traffic.
- 3.3 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS
- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
 - B. Install conduits and cable with no crossings within the sleeve.
 - C. Fill opening around conduits and cables with expanding foam without leaving voids.
 - D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

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3.4 INSTALLATION OF SLEEVE SEAL SYSTEMS

- A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 SLEEVES

- A. Furnish to the General Contractor sleeves and locations where work of this contract must pass through new walls, floors, ceilings, roofs, and other construction. Extend each sleeve through the floor, wall or partition and cut flush with each surface unless otherwise required.
- B. For sleeves in bearing and masonry walls, floors, and partitions provide standard weight steel pipe finished with smooth edges. For other than masonry partitions, through suspended ceilings, and for concealed vertical piping, provide No. 22 U.S.G. galvanized iron, unless otherwise specified.
- C. Where conduits pass through the roof provide pre-molded synthetic rubber flashing boots or other approved means approved by the Roofing Contractor. Install as per Roofing Contractor.
- D. Provide any sleeve or opening not installed or made during construction under the requirements for cutting and patching.
- E. Provide sleeves as required in existing walls for renovation projects.

3.6 FIELD QUALITY CONTROL

- A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
- B. Keep areas of work accessible until inspection by applicable code authorities.
- C. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops" or other recognized standard.
- D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

3.7 THROUGH-PENETRATION FIRESTOP SYSTEMS IDENTIFICATION

- A. Identify through-penetration firestop systems with adhesive labels.
- B. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems.
- C. Include the following information on labels:
 - 1. The words: "Warning - Through Penetration Firestop System-Do Not Disturb"
 - 2. Contractor's Name, address, and phone number.
 - 3. Through-Penetration firestop system designation of applicable testing and inspecting agency.
 - 4. Date of Installation.
 - 5. Through-Penetration firestop system manufacturer's name.
 - 6. Installer's Name.

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3.8 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 firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that firestop system 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 firestop system and install new materials to produce systems complying with specified requirements.

END OF SECTION 260544

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SECTION 260553 – IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Labels and Nameplates
- B. Color-Coding

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code

1.3 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.4 SUBMITTALS FOR REVIEW

- A. Submit a letter on Company letterhead stating that all equipment will be in compliance with the specifications.

1.5 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Thomas & Betts
- B. Ideal Industries, Inc.
- C. Lem Products, Inc.

2.2 RACEWAY AND CABLE LABELS

- A. Comply with applicable codes for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - 1. Color: Black letters on orange field.
 - 2. Legend: Indicates voltage and service.
- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend over-laminated with a clear weather and commercial resistant coating.
- C. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.

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- D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 3/4" to 2" wide.
- E. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- F. Aluminum, Wraparound Market Bands: Bands cut from 0.014" thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- G. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.
- H. Aluminum-Faced, Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002" thick, laminated with moisture resistant acrylic adhesive, punched for fasteners, and preprinted with legends to suit each application.
- I. Brass or Aluminum Tags: 2 by 2 by 0.05" metal tags with stamped legend, punched for fastener.
- J. Telecommunication Cable Labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

2.3 NAMEPLATES AND SIGNS

- A. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16" thick for signs up to 20 sq. in. and 1/8" thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Provide outdoor rated plastic with UV Protection for outdoor or wet locations.
- B. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend and size required for the application. 1/4" grommets in corners for mounting.
- C. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16"
 - 2. Tensile Strength: 50 lb minimum.
 - 3. Temperature Range: Minus 40 to plus 185° F.

2.5 COLOR CODING OF SECONDARY CONDUCTORS

- A. Use the following colors for feeder and branch circuit phase conductors:
 - 1. 120/208 or 120/240 Volt Systems:
 - Black – A-Phase
 - Red – B-Phase
 - Blue – C-Phase
 - White (Neutral)
 - 2. 277/480 Volt Systems:
 - Brown – A Phase
 - Orange – B Phase
 - Yellow – C Phase
 - Gray (Neutral)
 - 3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 3" from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no

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tension to prevent possible unwinding. Use 3/4" wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use Owner-furnished room numbers on all identifications. Room numbers on drawings are for reference only.
- B. Verify colors for color coding with Owner before proceeding and match existing color coding when applicable.
- C. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- D. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
- E. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
- F. Self-Adhesive Identification Products: Clean surfaces before applying.
- G. Color Junction Boxes and Coverplates: Paint all boxes and covers above accessible ceilings colors as listed below:
 - 1. Fire Alarm System: Red
 - 2. Security System: Blue
 - 3. Normal/Emergency and Emergency Only Distribution Systems: Yellow
- H. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
- I. Circuit Identification on Junction Boxes and Coverplates: Mark ID externally on junction box, coverplates and on the back of each coverplate for receptacles and switches.
 - 1. Boxes: Finished Areas – Inside, Permanent Marker
 - 2. Boxes: Non-Finished Areas – Outside, Permanent Marker
 - 3. ID Legend: Permanent, waterproof listing of panel and circuit number or equivalent. (IE Panel HA cct. 1, 3, 5)
- J. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8" below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16" overall, use a single line marker. For trenches wider than 16" install parallel tapes at 2'-0" intervals across the width of the trench.
- K. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes and switchboard rooms.
 - 1. Legend: 1/4" steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 - 2. Tag Fasteners: Nylon cable ties.
 - 3. Band Fasteners: Integral ears.
- L. Apply identification to conductors as follows:
 - 1. Conductors to be extended in the future: Indicate source and circuit numbers.

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2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor's source and circuit number using permanent marking and using color-coding to identify circuits' voltage and phase.
 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding or cable marking tape.
- M. Apply warning, caution and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8" high lettering for emergency instructions on power transfer, load shedding and other emergency operations.
- N. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2" high lettering on 1-1/2" high label; where two lines of text are required, use labels 2" high. Use black letters on a white face. Apply labels for each unit of the following categories of equipment using punched or drilled mechanical fasteners.
1. Transformers
 2. Switchboards (3/8" high letters)
 3. Panelboards
 4. Load Centers
 5. Enclosed Switches
 6. Enclosed Circuit Breakers
 7. Elevator Enclosed Switches
 8. Enclosed Contactors
 9. Enclosed Controllers
 10. Engine Generators (3/8" high letters)
 11. Fixed and Automatic Power Factor Equipment
 12. Transfer Switches (3/8" high letters)
 13. Area Protection Panels

END OF SECTION 260553

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SECTION 260573 – OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes performing fault-current study, coordination study and overcurrent protective device setting by manufacturers representative.

1.2 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section
 - b. A list of all computer software programs to be used for all studies
 - c. Coordination-Study input data
 - d. Coordination-Study Report
 - e. Fault Current-Study Report
 - f. Equipment Evaluation Report
 - g. Manufacturers Setting Report
 - h. Professional Engineers stamp/signature for the state the project is located.

1.3 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Manufacturers field service to notify Engineer in writing that all overcurrent protective device settings were correctly adjusted with Electrical Contractor to the values listed in the study results.

1.4 QUALIFICATIONS

- A. Software Qualifications: Software algorithms shall comply with requirements of industry standards and shall be as recommended by switchgear and panelboard manufacturer. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices. Manual calculations are not acceptable.
- B. Studies Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices. Engineer to have at least 5 years of experience performing short circuit and coordination studies.
- C. Testing Agency Qualifications: Member of the International Electrical Testing Association.
- D. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise testing specified in this section.

PART 2 - PRODUCTS

2.1 UTILITY INFORMATION

- A. Refer to Section 260583.

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2.2 STUDIES

- A. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D. This study shall also include short-circuit and protective device coordination studies.
- B. Study shall include a Professional Engineers stamp/signature for the state the project is located.

2.3 DATA

- A. Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis 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 Contract Documents provided by Owner, or Contractor.
- 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.

2.4 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
 - 7. The Contractor shall be responsible for supplying conductor information (lengths, types, number per phase, etc.) in a timely manner to allow the short-circuit analysis to be completed prior to final installation.
- 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. The manufacturers study specialist shall notify Owner in writing, of any circuit protective devices improperly rated for the calculated available fault current.

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2.5 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.

2.6 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA 70E, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis (Section 2.3) and the protective device time-current coordination analysis (Section 2.4)
- B. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway, and splitters) where work could be performed on energized parts.
- C. Circuits 240V or less fed by single transformer rated less than 125 kVA may be omitted from the computer model and will be assumed to have a hazard risk category 0 per NFPA 70E.
- D. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.

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- E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.
 - 1. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.
- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond 5 cycles.
- H. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required, and it shall be based on a device located upstream of the equipment to clear the arcing fault.
- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- J. Miss-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
- L. Provide the following:
 - 1. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.
 - 2. The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.
 - 3. The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.
- B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

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3.2 OVERCURRENT PROTECTIVE DEVICE SETTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of adjustable overcurrent protective devices within equipment.
- B. Testing: Perform the following device setting and prepare reports:
 - 1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
 - a. Verify that overcurrent protective devices meet parameters used in studies.
 - b. Adjust devices to values listed in study results.

3.3 GROUND FAULT PROTECTIVE DEVICE SETTING/TESTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of ground-fault protective devices within equipment.
- B. Testing: perform the following device setting and prepare reports:
 - 1. After installing ground-fault protective devices and during energizing process of electrical distribution system, perform the following:
 - a. Service ground-fault protective device setting in accordance with Article 230 of the NEC.
 - b. Service ground-fault protective device performance testing and written record in accordance with Article 230 of the NEC.
 - c. Other ground fault devices in accordance with the fault current study.

3.4 ARC FLASH LABELS

- A. Provide a 4" x 4" Brady thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The labels shall be designed according to the following standards:
 - 1. UL969 – Standard for Marking and Labeling Systems
 - 2. ANSI Z535.4 – Product Safety Signs and Labels
 - 3. NFPA 70 (National Electric Code) – Article 110.16
- C. The label shall include the following information:
 - 1. System Voltage
 - 2. Flash protection boundary
 - 3. Personal Protective Equipment category
 - 4. Arc Flash Incident energy value (cal/cm²)
 - 5. Limited, restricted, and prohibited Approach Boundaries
 - 6. Study report number and issue date
- D. Labels shall be printed by a thermal transfer type printer with no field markings.
- E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:
 - 1. Floor Standing Equipment - Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
 - 2. Wall Mounted Equipment – Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.
 - 3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

END OF SECTION 260573

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SECTION 260620 – SCHEDULES FOR ELECTRICAL DISTRIBUTION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the schedules for electrical distribution equipment.

1.2 SUBMITTALS FOR REVIEW

- A. Refer to the specific equipment section for submittals required.

1.3 EXTRA MATERIALS

- A. Refer to the specific equipment section for extra materials required.

1.4 MAINTENANCE MATERIALS

- A. Refer to the specific equipment section for maintenance materials required.

PART 2 - PRODUCTS

2.1 SCHEDULES FOR ELECTRICAL DISTRIBUTION EQUIPMENT

- A. Refer to Schedules attached to the following pages.

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PART 3 - EXECUTION

3.1 STANDARD BRANCH CIRCUIT WIRE SIZING TABLE

A. Sizing Table:

STANDARD BRANCH CIRCUIT WIRE SIZING TABLE			
BREAKER TRIP RATING	1-POLE BREAKER	2-POLE BREAKER	3-POLE BREAKER
15-20A	2#12 + 1#12 GND IN 3/4" CONDUIT	3#12 + 1#12 GND IN 3/4" CONDUIT	4#12 + 1#12 GND IN 3/4" CONDUIT
25-30A	2#10 + 1#10 GND IN 3/4" CONDUIT	3#10 + 1#10 GND IN 3/4" CONDUIT	4#10 + 1#10 GND IN 3/4" CONDUIT
35-40A	2#8 + 1#10 GND IN 3/4" CONDUIT	3#8 + 1#10 GND IN 3/4" CONDUIT	4#8 + 1#10 GND IN 3/4" CONDUIT
45-50A	2#6 + 1#10 GND IN 3/4" CONDUIT	3#6 + 1#10 GND IN 3/4" CONDUIT	4#6 + 1#10 GND IN 1" CONDUIT
60-70A	2#4 + 1#8 GND IN 1" CONDUIT	3#4 + 1#8 GND IN 1-1/4" CONDUIT	4#4 + 1#8 GND IN 1-1/4" CONDUIT
80A	2#3 + 1#8 GND IN 1" CONDUIT	3#3 + 1#8 GND IN 1-1/4" CONDUIT	4#3 + 1#8 GND IN 1-1/4" CONDUIT
90A	N/A	3#2 + 1#8 GND IN 1-1/4" CONDUIT	4#2 + 1#8 GND IN 1-1/4" CONDUIT
100-110A	N/A	3#1 + 1#6 GND IN 1-1/2" CONDUIT	4#1 + 1#6 GND IN 1-1/2" CONDUIT

B. Table Notes:

1. Unless otherwise indicated, refer to this schedule for wire and conduit size for all circuits with identified breaker trip ratings.
2. Provide neutral conductor for 2 and 3 pole circuits as indicated above if the equipment requires a neutral.

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DISTRIBUTION PANEL DPV			Bus:	600A	Additional Notes	
			Main Type:	600A Main Breaker	100% Neutral with Ground Bus	
			Features:	E	Integral TVSS H2	
			Volts:	277/480V, 3PH, 4W	Customer Meter	
			Space:	As Shown		
			AIC:	22,000		
			Mounting:	Surface		
CKT.	Breaker		Type	Description	KVA	Notes
	Amp	Pole				
1	60	3	T	TVSS H2	-	1,2
2	100	3	E	Chryst Pavilion Panel CL1 (via T-CL1)	21.0	2
3	225	3	E	Baseball Panel (1st Base Dugout)	100.0	2
4	150	3	E	Panel VH1	97.5	2
5	150	3	E	Panel VL1 (via T-VL1)	41.9	2,6
6	300	3	E	Home Bleacher Panel HH1	118.6	2
7	70	3	E	Panel LS-VH1 (via ATS-LS)	22.7	2,11
8						
9						
10						
11						
12	60	3	E	Spare		
13	100	3	E	Spare		
14	225	3	E	Spare		
15	225	3		Prepared Space		
16	400	3		Prepared Space		
Total Connected Load KVA:					401.7	

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PANEL			Bus:	225A Main Lugs	Additional Panel Notes										
VH1			Volts:	277/480V, 3PH, 4W	100% Neutral with Ground Bus										
			Poles:	60	Integral TVSS H3										
			AIC:	14,000											
			Mounting:	Surface	Fed From: Distribution Panel DPV										
CKT.	Breaker		Description	Notes	Load						Notes	Description	Breaker		CKT.
	Amp	Pole			A		B		C				Pole	Amp	
1	30	3	Pole F1 - Football	3	2.7	0.6					3	Pole F1,F3,F4,F6 - FB Color	2	30	2
3							2.7	0.6							4
5									2.7						6
7	30	3	Pole F2 - Football	3	3.3	2.3					3	Pole F4,F5 - Practice Field	3	30	8
9							3.3	2.3							10
11									3.3	2.3					12
13	30	3	Pole F3 - Football	3	2.7	0.6					3,9	Pole A1,A2,B1,B2 - SB Color	2	30	14
15							2.7	0.6							16
17									2.7						18
19	30	3	Pole F4 - Football	3	2.7	2.5					3,9	Pole A1,A2 - Softball	3	30	20
21							2.7	2.5							22
23									2.7	2.5					24
25	30	3	Pole F5 - Football	3	3.3	2.5					3,9	Pole B1 - Softball	3	30	26
27							3.3	2.5							28
29									3.3	2.5					30
31	30	3	Pole F6 - Football	3	2.7	2.5					3,9	Pole B2 - Softball	3	30	32
33							2.7	2.5							34
35									2.7	2.5					36
37	30	3	Pole F2,F3,F4,F5 - Bleacher	3	1.9	2.2						ERV-V1	3	15	38
39							1.9	2.2							40
41									1.9	2.2					42
43	20	1	Ltg - Interior		0.2										44
45	20	1	Site Ltg - Poles	3			1.0								46
47	20	1	Spare												48
49	20	1	Spare												50
51	20	1	Spare									Spare	2	30	52
53	20	1	Spare												54
55	15	3	Spare									Spare	3	30	56
57															58
59															60
					32.7		33.5		31.3		Total Connected Load KVA: 97.5 KVA				
					Phase Totals										

**24-SDL-03 MCCASKEY HIGH SCHOOL STADIUM PROJECTS
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PANEL		Bus:	300A Main Breaker	Additional Panel Notes											
VL1		Volts:	120/208V, 3PH, 4W	100% Neutral with Ground Bus											
		Poles:	42 + 42	Integral TVSS L2											
		AIC:	10,000												
Section 1 of 2		Mounting:	Surface	Fed From: Panel DPV via T-VL1											
CKT.	Breaker		Description	Notes	Load						Notes	Description	Breaker		CKT.
	Amp	Pole			A		B		C				Pole	Amp	
1	15	1	Boiler B-1		1.4	0.7						Rec - Exterior North	1	20	2
3	15	1	Boiler B-1				1.4	0.5				Rec - Exterior West	1	20	4
5	15	2	CU-1 / HP-1						1.1	0.7		Rec - Exterior South	1	20	6
7					1.1	0.6					4	Rec - Water Cooler Ext. West	1	20	8
9	35	2	CU-2 / HP-2				2.5	0.7				Rec - Team Rm, Entry	1	20	10
11									2.5	1.1		Rec - Restrooms	1	20	12
13	35	2	CU-3 / HP-3		2.5	0.7						Rec - Storage	1	20	14
15							2.5	0.7				Rec - Storage	1	20	16
17	15	1	UHs, CUHs - South						0.5	1.0		Rec - Data Rack	1	20	18
19	15	1	UHs, CUHs - North		0.5	1.0						Rec - AV Rack	1	20	20
21	15	1	Circ Pump CP-1				0.8	1.0				Rec - AV Rack	1	20	22
23	20	1	Musco Ltg Control Panels						1.0	1.1		Rec - Storage/Mech	1	20	24
25	20	1	Softball Scoreboard	13	1.0	0.9						Rec - Press Box 1st Flr	1	20	26
27	20	1	DWH-1				0.3	0.5				Plugmold - Press Box 1st Flr	1	20	28
29	20	1	Fire Alarm Control Panel - Data Clst	7					1.0	1.1		Rec - Press Box 2nd Flr	1	20	30
31	20	1	Access Control Panel - Data Clst		0.5	0.7						Rec - Press Box 2nd Flr	1	20	32
33	20	1	Door Hardware Power Supplies				0.5	0.5				Plugmold - Press Box 2nd Flr	1	20	34
35	20	1	Generator Battery Charger	3					0.5	0.2	3	Rec - Pole Mounted	1	20	36
37	20	1	Generator Battery Heater	3	1.0	0.2					3	Rec - Pole Mounted	1	20	38
39	30	2	Generator Block Heater	3			1.0	0.2			3	Rec - Pole Mounted	1	20	40
41									1.0	0.2	3	Rec - Pole Mounted	1	20	42
					13.8		14.1		14.0		Total Connected Load KVA: 41.9 KVA				
					Phase Totals										

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PANEL		Bus:	300A Main Breaker	Additional Panel Notes										
VL1		Volts:	120/208V, 3PH, 4W	100% Neutral with Ground Bus										
		Poles:	42 + 42	Integral TVSS L2										
		AIC:	10,000											
		Mounting:	Surface	Fed From: Panel DPV via T-VL1										
Section 2 of 2														
CKT.	Breaker		Description	Notes	Load					Notes	Description	Breaker		CKT.
	Amp	Pole			A	B	C	Pole	Amp					
43	15	3	HWP-1		0.5									44
45							0.5							46
47									0.5					48
49	15	3	HWP-3		0.5									50
51							0.5							52
53									0.5					54
55														56
57														58
59														60
61														62
63														64
65														66
67	15	1	Spare								Spare	2	15	68
69	15	1	Spare											70
71	20	1	Spare								Spare	2	20	72
73	20	1	Spare											74
75	20	1	Spare								Spare	2	25	76
77	20	1	Spare											78
79	20	1	Spare								Spare	3	20	80
81	20	1	Spare											82
83	20	1	Spare	4										84
					13.8		14.1		14.0		Total Connected Load KVA: 41.9 KVA			
					Phase Totals									

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SCHOOL DISTRICT OF LANCASTER PROJECT # CP802

PANEL		Bus:	300A Main Breaker	Additional Panel Notes											
HH1		Volts:	277/480V, 3PH, 4W	100% Neutral with Ground Bus											
		Poles:	60	Integral TVSS H3											
		AIC:	14,000												
		Mounting:	Surface	Fed From: Distribution Panel DPV											
CKT.	Breaker		Description	Notes	Load						Notes	Description	Breaker		CKT.
	Amp	Pole			A		B		C				Pole	Amp	
1	15	3	ERV-H1		3.3	0.4					13	Ltg - Practice Field Floodlights	3	20	2
3							3.3	0.4							4
5									3.3	0.4					6
7	40	3	VRF-1		6.6	0.4					3	Site Ltg - Poles	1	20	8
9							6.6	0.2			3	Site Ltg - Flagpole	1	20	10
11									6.6	1.9		Ltg - Interior	1	20	12
13	40	3	VRF-2		6.6										14
15							6.6								16
17									6.6						18
19	15	3	HWP-3		1.3							Spare	1	20	20
21							1.3					Spare	1	20	22
23									1.3			Spare	1	20	24
25	15	3	HWP-4		1.3							Spare	3	20	26
27							1.3								28
29									1.3						30
31	15	3	Spare			4.0					2	Baseball Panel (3rd Base Dugout)	3	20	32
33								4.0							34
35										4.0					36
37	40	3	Spare			15.8					2	Panel HL1 (via T-HL1)	3	150	38
39								15.2							40
41										14.6					42
					39.7		38.9		40.0		Total Connected Load KVA: 118.6 KVA				
					Phase Totals										

**24-SDL-03 MCCASKEY HIGH SCHOOL STADIUM PROJECTS
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PANEL		Bus:	300A Main Breaker	Additional Panel Notes											
HL1		Volts:	120/208V, 3PH, 4W	100% Neutral with Ground Bus											
		Poles:	42 + 42	Integral TVSS L2											
		AIC:	10,000												
Section 1 of 2		Mounting:	Surface	Fed From: Panel HH1 via T-HL1											
CKT.	Breaker		Description	Notes	Load						Notes	Description	Breaker		CKT.
	Amp	Pole			A		B		C				Pole	Amp	
1	15	1	Boiler B-2		1.4	0.5						Rec - Exterior North	1	20	2
3	15	1	Boiler B-2				1.4	0.5				Rec - Exterior South	1	20	4
5	25	2	CU-4 / HP-4						1.8	0.5		Rec - Exterior East	1	20	6
7					1.8	0.6					4	Rec - Water Cooler Exterior North	1	20	8
9	15	2	CU-5 / HP-5				1.1	0.6			4	Rec - Water Cooler Exterior South	1	20	10
11									1.1	0.9		Rec - Women's Restroom, JC	1	20	12
13	15	2	FCU-1 thru FCU-6		0.4	0.9						Rec - Open Storage	1	20	14
15							0.4	0.7				Rec - Open Storage, FB Storage	1	20	16
17	15	2	FCU-7 thru FCU-10						0.3	0.9		Rec - Trainer Rm	1	20	18
19					0.3	0.6						Rec - UC Refrig - Trainer Rm	1	20	20
21	15	1	Boiler B-2					0.5			4	Rec - Ice Maker - Trainer Rm	1	20	22
23	15	1	Boiler B-2							0.5	4	Rec - Ice Maker - Trainer Rm	1	20	24
25	15	1	UHs, CUHs - South		0.5	0.7						Rec - Trainer Rm	1	20	26
27	15	1	UHs, CUHs - North				0.5	0.7				Rec - Team Rm	1	20	28
29	15	1	UHs - 2nd Floor						0.5	0.7		Rec - Men's Restroom	1	20	30
31	20	1	VRF Controller - 2nd Floor Mech		0.5	1.1						Rec - 2nd Floor Mechanical	1	20	32
33	20	1	Rec - Press Box				1.3	1.0				Rec - Data Rack	1	20	34
35	20	1	Rec - AV Rack						1.0	1.3		Rec - 2nd Floor	1	20	36
37	20	1	Rec - AV Rack		1.0	1.1						Rec - 2nd Floor	1	20	38
39	20	1	Plugmold - Press Box				0.5	1.0				Overhead Door	1	20	40
41	20	1	Musco Ltg Controller - Press Box						0.5	0.5		Ltg Relay Panel - 2nd Floor	1	20	42
					15.8		15.2		14.6		Total Connected Load KVA: 45.6 KVA				
					Phase Totals										

**24-SDL-03 MCCASKEY HIGH SCHOOL STADIUM PROJECTS
SCHOOL DISTRICT OF LANCASTER PROJECT # CP802**

PANEL		Bus:	300A Main Breaker	Additional Panel Notes											
HL1		Volts:	120/208V, 3PH, 4W	100% Neutral with Ground Bus											
		Poles:	42 + 42	Integral TVSS L2											
		AIC:	10,000												
Section 2 of 2		Mounting:	Surface	Fed From: Panel HH1 via T-HL1											
CKT.	Breaker		Description	Notes	Load						Notes	Description	Breaker		CKT.
	Amp	Pole			A		B		C				Pole	Amp	
43	20	1	Floorbox Rec - Workout Rm		0.5	0.9						Rec - Vestibule, Restrooms	1	20	44
45	20	1	Floorbox Rec - Workout Rm				0.5	0.5				Rec - Workout Rm	1	20	46
47	20	1	Floorbox Rec - Workout Rm						0.5	0.5		Rec - Workout Rm	1	20	48
49	20	1	Floorbox Rec - Workout Rm		0.5	0.2						Rec - Workout Rm	1	20	50
51	20	1	Floorbox Rec - Workout Rm				0.5	0.2				Rec - Workout Rm	1	20	52
53	20	1	Floorbox Rec - Workout Rm						0.5	0.2		Rec - Workout Rm	1	20	54
55	20	1	Floorbox Rec - Workout Rm		0.5	0.2						Rec - Workout Rm	1	20	56
57	20	1	Floorbox Rec - Workout Rm				0.5	0.2				Rec - Workout Rm	1	20	58
59	20	1	Floorbox Rec - Workout Rm						0.5	0.2		Rec - Workout Rm	1	20	60
61	20	1	Rec - Water Cooler - Workout Rm	4	0.6	0.2						Rec - Workout Rm	1	20	62
63	20	1	Rec - Workout Rm TVs				0.7	0.4				Rec - Workout Rm	1	20	64
65	15	1	Circ Pump CP-1 - 2nd Floor						0.8	0.4		Rec - Workout Rm	1	20	66
67	20	1	DWH-1 - 2nd Floor		0.3							Spare	1	20	68
69	20	1	Fire Alarm Control Panel - Data Clst	7			1.0					Spare	1	15	70
71	20	1	Access Control Panel - Data Clst						0.5			Spare	2	15	72
73	20	1	Door Hardware Power Supplies		0.5										74
75	20	1	Door Hardware Power Supplies				0.5					Spare	2	20	76
77	20	1	Spare												78
79	20	1	Spare									Spare	3	20	80
81	20	1	Spare												82
83	20	1	Spare	4											84
					15.8		15.2		14.6		Total Connected Load KVA: 45.6 KVA				
					Phase Totals										

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PANEL			Bus:	225A Main Lugs	Additional Panel Notes										
LS-VH1 (LIFE-SAFETY)			Volts:	277/480V, 3PH, 4W	100% Neutral with Ground Bus										
			Poles:	24	Integral TVSS H2										
			AIC:	14,000	Feed-Thru Lugs										
			Mounting:	Surface	Fed From: Distribution Panel DPV and Generator via ATS-LS										
CKT.	Breaker		Description	Notes	Load						Notes	Description	Breaker		CKT.
	Amp	Pole			A		B		C				Pole	Amp	
1	15	1	Emergency Ltg - Exterior Step Lights	3	0.5	2.5					3	Pole F2,F3,F4,F5 - Egress	3	30	2
3	15	1	Emergency Ltg - Exterior Bldg Mtd				0.6	2.5							4
5	15	1	Emergency Ltg - Interior South						2.1	2.5					6
7	15	1	Emergency Ltg - Interior North, Pressbox		2.1	0.5						Exit Signs	1	15	8
9															10
11															12
13															14
15															16
17															18
19	15	1	Spare			3.5					2	Panel LS-HH1	-	-	20
21	15	1	Spare					2.9				(Feed-Thru Lugs)			22
23	15	1	Spare							3.0					24
					9.1		6.0		7.6						
					Phase Totals						Total Connected Load KVA: 22.7 KVA				

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PANEL			Bus:	225A Main Lugs	Additional Panel Notes										
LS-HH1 (LIFE-SAFETY)			Volts:	120/208V, 3PH, 4W		100% Neutral with Ground Bus									
			Poles:	24		Integral TVSS L3									
			AIC:	10,000											
			Mounting:	Surface		Fed From: Panel LS-VH1 feed-thru lugs									
CKT.	Breaker		Description	Notes	Load						Notes	Description	Breaker		CKT.
	Amp	Pole			A		B		C				Pole	Amp	
1	15	1	Emergency Ltg - Interior South		2.4	0.5						Exit Signs	1	15	2
3	15	1	Emergency Ltg - Weight Rm & 2nd Flr				2.9								4
5	15	1	Emergency Ltg - Interior North, Pressbox						3.0						6
7	15	1	Emergency Ltg - Exterior Bldg Mtd		0.6										8
9															10
11															12
13															14
15															16
17															18
19	15	1	Spare									Spare	1	15	20
21	15	1	Spare									Spare	1	15	22
23	15	1	Spare									Spare	1	15	24
					3.5		2.9		3.0		Total Connected Load KVA: 9.4 KVA				
					Phase Totals										

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PANELBOARD			Bus:	200A Main Breaker	Additional Panel Notes										
CL1			Volts:	120/208V, 3PH, 4W	100% Neutral with Ground Bus										
			Poles:	54	Integral TVSS L3										
			AIC:	10,000											
			Mounting:	Surface	Fed From: Distribution Panel DPV via T-LC										
CKT.	Breaker		Description	Notes	Load						Notes	Description	Breaker		CKT.
	Amp	Pole			A		B		C				Pole	Amp	
1	20	1	Rec - Countertop West (Left)		0.2	0.2						Rec - Countertop West (Right)	1	20	2
3	20	1	Rec - Countertop West (Left)				0.2	0.2				Rec - Countertop West (Right)	1	20	4
5	20	1	Kitchen Lights	13					-	-	13	Back Rooms Lights	1	20	6
7	20	1	Freezer Rec - This Room	13	-	-					13	Ticket Room Recs	1	20	8
9	20	1	Cord Reel - West				0.5					Spare	1	20	10
11	20	1	Upstairs Recs	13					-	-	13	Water Heater	2	30	12
13	20	1	Cord Reel - East		0.5	-									14
15	20	1	Rec - Countertop North (Left)				0.2	0.2				Rec - Countertop East (Left)	1	20	16
17	20	1	Rec - Countertop North (Left)						0.2	0.2		Rec - Countertop East (Left)	1	20	18
19	20	1	Rec - Countertop North (Center)		0.2	0.2						Rec - Countertop East (Right)	1	20	20
21	20	1	Rec - Countertop North (Center)				0.2	0.2				Rec - Countertop East (Right)	1	20	22
23	20	1	Rec - Countertop North (Right)						0.2	1.0	4	Rec - Refrigerator	1	20	24
25	20	1	Rec - Countertop North (Right)		0.2	1.4					4	Rec - Bev Cooler	1	20	26
27	20	1	Spare					1.4			4	Rec - Bev Cooler	1	20	28
29	20	1	Rec - Refrigerator	4					1.0			Spare	2	15	30
31	20	1	Rec - Refrigerator	4	1.0										32
33	20	1	Rec - Refrigerator	4			1.0	-			13	Pole Lights	2	20	34
35	20	1	Rec - Refrigerator	4					1.0	-					36
37	20	1	Rec - Refrigerator	4	1.0	1.2						Radiant Heat - Concessions	2	15	38
39	15	1	Spot Light	13			-	1.2							40
41	15	1	Spare							1.0		Radiant Heat - Concessions	2	15	42
43	20	1	Spare			1.0									44
45	20	1	Spare					1.0				Radiant Heat - Prep, Storage	2	15	46
47	20	1	Spare							1.0					48
49	20	1	Spare			1.0						Radiant Heat - Tickets,Restrooms	2	15	50
51	20	2	Spare					1.0							52
53											4	Spare	1	20	54
					8.1		7.3		5.6		Total Connected Load KVA: 21.0 KVA				
					Phase Totals										

PANEL NOTES	
1	Provide conductors, overcurrent device and exact placement as recommended by the TVSS manufacturer.
2	Refer to Power Riser Diagram for wire and conduit sizes.
3	Refer to Site Plan for wire and conduit sizes.
4	Provide groundfault breaker for personal protection.
5	Provide groundfault breaker for equipment protection.
6	Provide a permanently fastened pad lockable breaker accessory for servicing.
7	Provide Space Age Electronics Model ELOCK-FA for breaker to lock in the ON position and identify breaker.
8	Provide 2#10 + 1#10 gnd in 3/4" conduit for voltage drop.
9	Load and branch circuit wiring is part of a bid alternate. Label breaker as "Spare" if bid alternate is not accepted.
10	Provide electronic mission critical breaker that selectively coordinates with all upstream and downstream overcurrent devices.
11	Provide with minimum 225A sensor and breaker type that is listed by ATS-LS manufacturer to meet the required WCR/AIC ratings. EC to coordinate as needed.
12	Provide electronic trip breaker with Long Time, Short Time, and Instantaneous adjustments.
13	Existing load/circuit to remain; previously fed from demolished/relocated panelboard / load center. Rework existing wire and raceway as needed for new construction. Match and extend existing wiring and connect to new panelboard / load center. If existing breaker/circuit is found to serve equipment which is no longer active or has been demolished, contractor shall remove any existing wiring/conduit and mark breaker as "Spare" on panel schedule.

SWITCHBOARD/DISTRIBUTION PANEL BREAKER TYPES	
T	Thermal Magnetic
E	Electronic Trip with Long Time, Short Time, Instantaneous Setting Adjustments
ZSI	Zone-Selective Interlocking
EP	Energy/Power Trip Unit with Long Time, Short Time, Instantaneous Setting Adjustments, Zone Selective Interlock, Breaker Status Display & Modbus Wired Communications
GF	Ground Fault Protection
ST	Shunt Trip breaker accessory
HC	Permanently fastened pad lockable breaker accessory for servicing
AERS	Arc Energy Reduction Switch per NEC 240.87

**24-SDL-03 MCCASKEY HIGH SCHOOL STADIUM PROJECTS
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SECTION 260650 – LUMINAIRE SCHEDULE

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the Luminaire Schedule.
- B. The luminaire manufacturers' catalog numbers scheduled hereinafter in the Luminaire Schedule may not include all the required accessories or hardware that is necessary for a complete installation. Provide all the required accessories or hardware that is necessary for a complete installation.
- C. Furnish luminaries with all associated appurtenances including, but not necessarily limited to, lamps, ballasts, drivers, reflectors, lenses and/or louvers, sockets, holders, suspension accessories, pendants, canopies, recessing boxes, plaster frames, and similar items completely wired, assembled, installed, and tested as specified and in the manner indicated.
- D. Every luminaire symbol shall have a luminaire number unless otherwise directed. In instances where a specific luminaire symbol has not been assigned a luminaire number, provide a complete luminaire of the type and wattage designated for a luminaire symbol of similar function and/or as directed by the Engineer.

1.2 LUMINAIRE SCHEDULE INTERPRETATION

- A. The first name luminaire manufacturer and catalog number is the Basis of Design for the intended usage. Additional luminaire manufacturers and catalog series of luminaries listed in the Luminaire Scheduled or added thru addenda are approved equals and may be subject to sample review, footcandle layout for rooms utilizing luminaire and/or a mock-up for Engineer review before final approval will be given.

1.3 MAINTENANCE MATERIALS

- A. Provide 2 of each special tool required for maintenance.

PART 2 - PRODUCTS

2.1 LUMINAIRE SCHEDULE

- A. Refer to Luminaire Schedule attached to the following pages.

PART 3 - EXECUTION – NOT USED

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SECTION 260650 - LUMINAIRE SCHEDULE

Mark	Manufacturer	Catalog Number	Description	Volts	Lamps			Driver		Mtg.	Mtg. Height	Notes
					No.	Watts	Type/ Lumens	No.	Type			
CH1	Daybrite Lithonia Columbia Metalux ILP	FSS-4-55L-835-UNV-DIM ZL1D Series LCL Series SNLED Series DSC4 Series	4' Industrial	UNV	1	45	LED 5500	1	DLD	CH	8'-0" min	1,5
CH2	Daybrite Lithonia Columbia Metalux ILP	FSS-2-30L-835-UNV-DIM ZL1D Series LCL Series SNLED Series DSC4 Series	2' Industrial	UNV	1	26	LED 3000	1	DLD	CH	8'-0" min	1,5
EM1	Philips Chloride Lithonia Emergi-Lite Sure-Lites Evenlite	VLТУ ELM2 Series EL-2SQL Series SEL Series TCL Series	Emergency Lighting Battery Pack	UNV	2	1	LED 200	-	-	SW	7'-0" AFF	
EX1	Philips Chloride Lithonia Emergi-Lite Sure-Lites Evenlite	60MLA-X-G-W-XX LVS Series SVX Series UX60 Series TWL Series	High Abuse - LED Exit Sign Single/Dual Face	UNV	-	-	LED	-	-	SW/SC		2,3
OP1	NLS Gardco LSI Lithonia McGraw-Edison	NV-2-T4-80L-7-30K7-UNV-ASA-XX-FSP-40 P26 Series Mirada Series RSX2 Series GLEON Series	LED Single Head Pole Mounted Site Light w/ Integral Motion Sensor – Type 4	UNV	1	168	LED 18992	1	DLD	PM	25'-0"	6,8
OP2	NLS Gardco LSI Lithonia McGraw-Edison	(2) NV-2-T4-80L-7-30K7-UNV-ASA-XX-FSP-40 P26 Series Mirada Series RSX2 Series GLEON Series	LED Dual Head Pole Mounted Site Light w/ Integral Motion Sensor – (2) Type 4 Mounted @ 180-Degrees	UNV	1	336	LED 37984	1	DLD	PM	25'-0"	6,8
OP3	Kirlin Luminis Ligman	LWR-09490-5000L-277-30K-XX-XX SC855 series UMV-300xx series	Pole Mounted LED Flagpole Floodlight	UNV	1	57.4	LED 4895	1	DLD	PM	See Notes	4,6,8
OW1	Luminaire Evenlite Signtex	AEL-24IN-MIN10-20W-30K-MVOLT-DP-XX MM Series MUE Series	Exterior LED Wall- Mounted Fixture	UNV	1	20	LED 1557	1	DLD	SW	See Notes	6,7,9

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Mark	Manufacturer	Catalog Number	Description	Volts	Lamps			Driver		Mtg.	Mtg. Height	Notes
					No.	Watts	Type/ Lumens	No.	Type			
OW2	Gardco McGraw-Edison Hubbell Outdoor Lithonia NLS	121-16L-1000-WW-G4-3-UNV-DD-XX ISC Series TRP Series WST Series NV-W Series	Exterior LED Wall-Mounted Fixture - Type 3 Distribution	UNV	1	55	LED 4915	1	DLD	SW	See Notes	6,7,9
OW3	Gardco McGraw-Edison Hubbell Outdoor Lithonia NLS	121-32L-700-WW-G4-4-UNV-DD-XX ISC Series TRP Series WST Series NV-W Series	Exterior LED Wall-Mounted Fixture - Type 4 Distribution	UNV	1	70	LED 7732	1	DLD	SW	See Notes	6,7,9
OW4	Targetti DeltaLight Amerlux	ZEL-41-FW-XX-L2-30 Logic W Series Passo (PSL) Series	Exterior LED Steplight	UNV	1	9	LED 203	1	DLD	RW	See Notes	6,7,9
RC1	Focal Point Finelite 3G Lighting	FSM4PR-ALH-AF0-875LF-35K-1C-UNV-LD1-XX-WH-XX HP-WS-4W Series 3G-4RPE Series	4" Recessed Linear Perimeter	UNV	1	9 Per 1'	LED 875 Per 1'	1	DLD	RC	-	5
RC2	RAB TrulyGreen Solutions LSI Metalux Lithonia	EZPANFA-2X2-D10 88-22 Series SFP FS Series CGTS Series CPANL LED Series	2'x2' LED Edgelit Flat Panel	UNV	1	30	LED 4074	1	DLD	RC	-	10
SC1	Luminaire LED CertoLux Lifeshield	VPF8-4FT-MIN1-50W-35K-MVOLT-OP-XX VRSE-3556 Series PVNT Series	4' Ceiling Surface Mount Vandal-Resistant Wraparound	UNV	1	53.3	LED 5736	1	DLD	SC	-	5
SW1	Luminaire LED CertoLux Lifeshield	VPF8-4FT-MIN1-50W-35K-MVOLT-OP-XX-COR VRSE-3556 Series PVNT Series	4' Surface Mount Vandal-Resistant Wraparound w/ Corner Mount Backbox	UNV	1	53.3	LED 5736	1	DLD	SC	-	5

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Driver & Ballast Legend	
Symbol	Description
DLD	Dimming LED Driver, 0-10 volts.
LD	LED driver.
1LE	One lamp electronic
2LE	Two lamp electronic
3LE	Three lamp electronic
4LE	Four lamp electronic
FD	Fluorescent dimming as specified.
SD	Step Dimming
DMX	DMX Dimming Driver

Mounting Legend			
Symbol	Description	Symbol	Description
RC	Recessed Ceiling	S	Suspended
RW	Recessed Wall	UC	Under Cabinet
SC	Surface Ceiling	PD	Per Detail on Drawings
SW	Surface Wall	PM	Pole Mounted
CH	Chain Hung	IG	Recessed In-Ground
AH	Aircraft Cable Hung	PT	Pole Top Mounted
P	Pendant	T	Track
WB	Wall Bracket	B	Bollard
SF	Surface Floor		

General Notes	
G1	Check descriptions against catalog numbers. Report any discrepancies prior to submitting a proposal for this work.
G2	Where the listed manufacturer of acceptable substitutes makes more than one grade of the fixture, provide the grade of fixture with equal or better construction, materials and performance as determined by the manufacturer.
G3	Engineer must approve all substitutes prior to bid.
G4	All Recessed 1x4, 2x2 and 2x4 fixtures shall have spring-loaded latches. Cam action (friction) latches are not acceptable.
G5	All drivers/ballasts shall be Universal 120-277 voltage. If universal driver is unavailable, furnish 120 volt type.
G6	Refer to Specifications Sections 265100 and 265600 for additional requirements.
G7	All approved equal pendant manufacturers will be required to submit footcandle layouts to verify they meet the basis of design.

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Luminaire Notes	
1	Provide stem/chain length as required.
2	Provide single or double faces as required.
3	Provide all additional mounting accessories for each application.
4	Confirm recommended mounting height with manufacturer based on flag size provided by Owner. Confirm pole diameter at mounting height (tapered pole) with GC/Architect prior to ordering fixtures.
5	Provide continuous lengths as shown on the drawings.
6	Architect to select finish of luminaire. Provide color samples with submittals to Architect for review and selection.
7	Locations/Heights shown on Electrical Drawings are approximate. Coordinate exact mounting height and location with Architectural Elevations. Review with Architect before rough-in.
8	Provide 22' aluminum square pole with individual bolt covers. Provide pole base per Detail 6/E8.1 on the Drawings to mount pole and luminaries.
9	Review all field locations with Architect before rough-in.
10	Set all RC1 fixtures at 30W (4000 nominal lumens) output and 3500K color temperature.
11	

END OF SECTION 260650

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SECTION 260670 – DIGITAL LIGHTING RELAY CONTROL PANEL SCHEDULES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the attached Lighting Control Panel Schedules.

1.2 SUBMITTALS FOR REVIEW

- A. Refer to Section 260943 for submittals required.

1.3 EXTRA MATERIALS

- A. Refer to Section 260943 for extra materials required.

1.4 MAINTENANCE MATERIALS

- A. Refer to Section 260943 for maintenance materials required.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 LIGHTING CONTROL PANEL SCHEDULES

- A. Refer to Lighting Control Panel Schedules, attached to the following pages.

LIGHTING CONTROL PANEL LCP-V

Relay No.	Description	Voltage	Relay Type	Normal/ Emergency	Control Type	KVA	Panelboard Circuit
1	Site Ltg - Pole Lights	277	NON-DIM		T,P	1.0	VH1-45
2	Spare		NON-DIM				
3	Spare		DIM				
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15	Spare		NON-DIM	EMER			
16	Spare		DIM	EMER			
17	NE Ltg - Mechanical / Storage	277	NON-DIM	EMER	O,M	0.4	LS-VH1-7
18	NE Ltg - Storage	277	NON-DIM	EMER	O,M	0.6	LS-VH1-7
19	NE Ltg - Men's Restroom	277	NON-DIM	EMER	O	0.6	LS-VH1-7
20	NE Ltg - Women's Restroom	277	NON-DIM	EMER	O	0.9	LS-VH1-5
21	NE Ltg - Entry	277	NON-DIM	EMER	O	0.1	LS-VH1-5
22	NE Ltg - Team Room	277	DIM	EMER	O,M	0.2	LS-VH1-5
23	NE Ltg - Exterior Step Lights	277	NON-DIM	EMER	T,P	0.2	LS-VH1-1
24	NE Ltg - Exterior Bldg Mtd	277	DIM	EMER	T,P	0.6	LS-VH1-3

Abbreviations:

P Photocell
T Timeclock
O Occupancy Sensor
M Manual Local Wall Switch
EMER Emergency Relay (Override ON upon loss of normal power)
DIM 0-10V Dimming, ON/OFF Relay
NON-DIM ON/OFF switched relay

LIGHTING CONTROL PANEL LCP-H

Relay No.	Description	Voltage	Relay Type	Normal/ Emergency	Control Type	KVA	Panelboard Circuit
1	Site Ltg - Pole Lights	277	NON-DIM		T,P	0.4	HH1-8
2	Site Ltg - Flagpole	277	NON-DIM		T,P	0.2	HH1-10
3	Ltg - Workout Rm	277	DIM		O,M	1.7	HH1-12
4	Contactor - Practice Field Floods	277	NON-DIM		M,P	-	-
5	Spare		DIM				
6	Spare		NON-DIM				
7							
8							
9							
10							
11							
12							
13	Spare		DIM	EMER			
14	Spare		NON-DIM	EMER			
15	NE Ltg - 2nd Floor	277	NON-DIM	EMER	O,M	1.3	LS-HH1-3
16	NE Ltg - Men's Restroom	277	NON-DIM	EMER	O	0.7	LS-HH1-5
17	NE Ltg - Athletic Trainer Rm	277	DIM	EMER	O,M	0.3	LS-HH1-5
18	NE Ltg - Team Room	277	DIM	EMER	O,M	1.3	LS-HH1-5
19	NE Ltg - Vestibule	277	NON-DIM	EMER	O	0.1	LS-HH1-5
20	NE Ltg - Workout Rm	277	DIM	EMER	O,M	1.6	LS-HH1-3
21	NE Ltg - Stair	277	NON-DIM	EMER	O,M	0.1	LS-HH1-1
22	NE Ltg - Open Storage	277	NON-DIM	EMER	O,M	0.5	LS-HH1-1
23	NE Ltg - Women's Restroom	277	NON-DIM	EMER	O	1.8	LS-HH1-1
24	NE Ltg - Exterior	277	DIM	EMER	T,P	0.6	LS-HH1-7

Provide Integral Lighting Contactors for the Following:

1	Practice Field Floodlights	480	3P.20A		Relay 4	1.2	HH1-2,4,6
2	-						
3	-						

Abbreviations:

P Photocell
T Timeclock
O Occupancy Sensor
M Manual Local Wall Switch
EMER Emergency Relay (Override ON upon loss of normal power)
DIM 0-10V Dimming, ON/OFF Relay
NON-DIM ON/OFF switched relay

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SECTION 260800 – ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

- A. The purpose of this section is to specify the Division 26 responsibilities and participation in the commissioning process.
- B. Work under this contract shall conform to requirements of Division 1, General Requirements, Conditions of the Contract, and Supplementary Conditions. This specification covers commissioning of electrical systems which are part of this project.
- C. Commissioning work shall be a team effort to ensure that all electrical equipment and systems have been completely and properly installed, function together correctly to meet the design intent, and document system performance. Commissioning shall coordinate system documentation, equipment start-up, and verification and performance testing.
- D. The commissioning team shall be made up of representatives from the Owner, design professionals, major equipment suppliers, and electrical contractor. The lead person for each trade who will actually perform or supervise the work is to be designated as the representative to the commissioning team. Responsibility for various steps of the commissioning process shall be divided among the members of the commissioning team, as described in this section.
- E. The Commissioning Authority shall have responsibility for coordinating and directing each step of the commissioning process. The Authority shall be a true third party, not affiliated with any of the companies involved with the project design.
- F. Electrical system installation, start-up, testing, preparation of O&M manuals, and operator training shall be the responsibility of the Division 26 Electrical Contractor, with coordination, observation, verification and commissioning the responsibility of Commissioning Agent,
- G. The commissioning process does not relieve the Division 26 Electrical Contractor from the obligations to complete all portions of work in a satisfactory and fully operational manner.

1.2 QUALITY ASSURANCE

- A. Qualifications:
 - 1. The CTC (Certified Testing Company) performing the work of this section shall be qualified to test electrical equipment and is a NETA (National Electrical Testing Association)-certified testing agency. The CTC shall not be associated with the manufacturer of equipment or systems under test.
- B. Test Equipment:
 - 1. The Subcontractor shall provide all test equipment necessary to fulfill the checks and testing requirements. Test equipment shall have been calibrated within one (1) year of its use on the project.
 - 2. Refer to the Division 1 – Commissioning Requirements Section for additional requirements.

1.3 ROLES AND RESPONSIBILITIES

- A. Refer to Division 01, General Requirements, Conditions of the Contract, and Supplementary Conditions for the Commissioning Agent, Owner, Architect, and General Contractor roles and responsibilities.
- B. Electrical Contractor Responsibilities:
 - 1. Include cost to complete commissioning requirements for electrical systems in the contract price.
 - 2. Include requirements for submittal data, O&M data, and training in each purchase order or sub-contract written.

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3. Ensure cooperation and participation of specialty sub-contractors such as communications, data, etc.
4. Ensure participation of major equipment manufacturers in appropriate training and testing activities.
5. Attend Construction Phase coordination meetings scheduled by the Commissioning Agent.
6. Conduct electrical system orientation and inspection when equipment is set.
7. Respond to (in writing) and address items documented in the Contractor Commissioning Issues Log.
8. Submit copies of all test results to the CxA.
9. Complete Pre-Functional Checklists for all equipment.
 - a. Remedy any deficiencies identified in Pre-Functional Checklists and notify CxA in writing that deficiencies have been addressed.
10. Assist the Commissioning Agent in all Pre-Functional Checklist verifications and Functional Performance Tests.
11. Prepare preliminary schedule for electrical system orientation and inspections, O&M manual submission, training sessions, testing, equipment start up, and task completion for use by the Commissioning Agent. Update schedule as appropriate throughout the construction period.
12. Attend initial training session.
13. Conduct electrical system orientation and inspection at the equipment placement completion stage.
14. Update drawings to the record condition to date, and review with the Commissioning Agent.
15. Gather O&M data on all equipment and assemble in binders as required by the Commissioning Specification. Submit to Commissioning Agent for review prior to the completion of construction.
16. Notify the Commissioning Agent a minimum of two weeks in advance, so that witnessing equipment and system start-up and testing can begin.
17. Participate in, and schedule vendors and Contractors to participate in the training sessions as set up by the Commissioning Agent.
18. Provide a complete set of as-built records to the Commissioning Agent.

- C. Equipment Suppliers and Miscellaneous Contractors Responsibilities:
1. Include cost for commissioning requirements in the contract price.
 2. Provide submittals, and appropriate O&M manual sections.
 3. Attend initial commissioning coordination meeting scheduled by the Commissioning Agent.
 4. Participate in training sessions as scheduled by the Commissioning Agent.
 5. Demonstrate performance of equipment as applicable.

1.4 SCOPE OF WORK

- A. Commissioning work of Division 26 shall include, but not be limited to:
1. Testing and start-up of the equipment.
 2. Completion of Functional Checklists.
 3. Cooperation with the Commissioning Agent.
 4. Providing qualified personnel for participation in commissioning tests, including seasonal testing required after the initial testing.
 5. Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process.
 6. Providing operation and maintenance manuals, and as-built drawings to the Commissioning Agent for verification.
 7. Providing training and demonstrations for the systems specified in this Division.
- B. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems, and sub-systems. The following equipment and systems shall be evaluated:
1. Switchboards
 - a. Visual and Mechanical Inspection
 - 1) Verify engraved nameplate is installed with the proper identification.
 - 2) Verify engraved nameplate for each feeder overcurrent device showing name of load, each spare size and each available space size are installed with the proper identification.
 - 3) Verify mimic bus is installed to indicate all switchboard components.
 - 4) Inspect physical, electrical, and mechanical condition of switchboard and all components.
 - 5) Verify ground fault pickup and time-delay settings (if applicable) are setup per the coordination study.

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- 6) Verify that all circuit breakers are equipped with the correct rating plugs and current sensors.
 - 7) Verify all circuit breaker setting adjustments match the requirements of the coordination study.
 - 8) Verify customer metering is setup and connected to the data network.
 - b. Electrical Tests
 - 1) Access the meter information by the IP address to verify it is operational.
 - 2) Make ground fault pickup and time-delay setting adjustments (if applicable) in accordance with the coordination study.
 - 3) Make circuit breaker setting adjustments in accordance with the coordination study.
- 2. Distribution Panelboards (600A and Above)
 - a. Visual and Mechanical Inspection
 - 1) Verify engraved nameplate is installed with the proper identification.
 - 2) Verify typed circuit directory for panelboard is showing the correct room name and/or number.
 - 3) Inspect physical, electrical, and mechanical condition of panelboard and all components.
 - 4) Verify ground fault pickup and time-delay settings (if applicable) are setup per the coordination study.
 - 5) Verify that all circuit breakers are equipped with the correct rating plugs and current sensors.
 - 6) Verify all circuit breaker setting adjustments match the requirements of the coordination study.
 - 7) Verify customer metering is setup and connected to the data network.
 - b. Electrical Tests
 - 1) Access the meter information by the IP address to verify it is operational.
 - 2) Make ground fault pickup and time-delay setting adjustments (if applicable) in accordance with the coordination study.
 - 3) Make circuit breaker setting adjustments in accordance with the coordination study.
- 3. Lighting Control System (30% Sampling Rate)
 - a. Visual and Mechanical Inspection
 - 1) Verify lighting loads are circuited per the zones indicated on the drawings.
 - 2) Verify controllers with the correct relay quantity are installed in the correct location.
 - 3) Verify each occupancy sensor type is installed in the correct location.
 - 4) Verify each wall switch type is installed in the correct location.
 - 5) Verify each daylight sensor type is installed in the correct location.
 - 6) Verify partition controls are installed in the correct location.
 - 7) Verify exterior daylight sensors are installed in the correct location.
 - 8) Verify all controllers/network bridges/border routers are connected to the network.
 - 9) Verify segment manager is connected and can be access by the building management system.
 - 10) Verify all emergency lighting control devices are installed in the correct location.
 - b. Electrical Tests
 - 1) Test each controller relay is programmed to match the sequence of operation for normal and after hour modes.
 - 2) Test each occupancy sensor type is programmed to match the sequence of operation for normal and after hour modes.
 - 3) Test each wall switch type is programmed to match the sequence of operation for normal and after hour modes.
 - 4) Test each daylight sensor type is programmed to match the sequence of operation for normal and after hour modes.
 - 5) Test partition controls work with combined and separate rooms.
 - 6) Test exterior daylight sensors.
 - 7) Test connection to controllers/network bridges/border routers.
 - 8) Access the lighting control system by the IP address to verify it is operational.
 - 9) Test emergency lighting control devices.
- 4. Engine Generators & Transfer Switches
 - a. Visual and Mechanical Inspection
 - 1) Verify engraved nameplate are installed with the proper identification on the generators and transfer switches.
 - 2) Verify transfer switches are setup as required.
 - 3) Verify fuel source is connected or tank is full.

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- 4) Verify remote annunciator is connected and working.
- 5) Verify battery charger, block heater and additional generator equipment is connected to the circuits indicated.
- b. Electrical Tests
 - 1) Witness power failure simulation including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal. Use the connected load for all tests.
 - 2) Witness full load test utilizing portable test bank for 2 hours.
 - 3) Witness test alarm and shutdown circuits by simulating conditions.
 - 4) Witness multiple generator starts.
 - 5) Verify all operational data and start-up minimum time interval.
 - 6) Verify all generator-running characteristics.
 - 7) Verify battery-charging system.
5. Electrical support for mechanical equipment listed in the Commissioning of HVAC Systems.

1.5 SUBMITTALS FOR REVIEW

- A. The Commissioning Agent shall review the relevant submittals and provide any comments to the Engineer for inclusion in their review comments.
- B. The Commissioning Agent will review the approved submittals and prepare the functional test procedures required for the equipment to be commissioned.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Electrical Contractors shall furnish all special tools and equipment required for testing during the commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted to the Commissioning Agent for approval.

2.2 PROPRIETARY TEST EQUIPMENT

- A. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing and adjusting procedures have been completed and that testing and adjusting reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

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- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the Commissioning Agent.

3.2 TESTING VERIFICATION

- A. Prior to performance of testing Work, provide copies of reports, sample forms, checklists, and certificates to the Commissioning Agent.
- B. Notify the Commissioning Agent at least 10 days in advance of testing Work and provide access for the Commissioning Agent to witness testing Work.
- C. Provide technicians, instrumentation, and tools to verify testing of electrical systems at the direction of the Commissioning Agent.
 - 1. The Commissioning Agent will notify testing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing and adjusting report.
 - 4. Remedy the deficiency and notify the Commissioning Agent so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the Commissioning Agent.
- B. Scope of electrical testing shall include all components, equipment, and systems as outlined in this section.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response to input signals.
- D. Tests will be performed using design conditions whenever possible.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the Commissioning Agent and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The Commissioning Agent may direct that set points be altered when simulating conditions is not practical.
- G. The Commissioning Agent may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.4 REPORT

- A. Provide a written report of all outstanding electrical items that need to be corrected.

END OF SECTION 260800

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SECTION 260943 – DIGITAL LIGHTING RELAY CONTROL PANEL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Relay Panels and associated equipment.

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NEMA - National Electrical Manufacturers Association
- C. FCC emission standards
- D. UL - Underwriters Laboratories, Inc. Listings
- E. UL 924 - Standard for Emergency Lighting and Power Equipment

1.3 DESIGN / PERFORMANCE REQUIREMENTS

- A. Digital lighting relay control panel system shall consist of relay panels, control switches, photocells, and other controlling devices that suit the required lighting and electrical system parameters.
- B. System shall conform to requirements of NFPA 70.
- C. System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.
- D. System shall be listed under UL sections 916 and/or 508.

1.4 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed in the system.
 - c. Data sheets of all items to be provided with the specific item or model number highlighted.
 - d. Show exact location of all digital devices, including at minimum sensors, relay panels and switches for each area on reflected ceiling plans. (Contractor must provide AutoCAD format reflected ceiling plans.)
 - e. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.

1.5 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual installed locations and settings of all equipment installed on the project record documents.
- C. Operation and Maintenance Manual:
 - 1. Include approved Shop Drawings and Product Data.

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2. Include Sequence of Operation, identifying operation for each room or space.
3. Include manufacturer's maintenance information.
4. Operation and Maintenance Data: Include detailed information on device programming and setup.
5. Include startup and test reports.

D. Maintenance Data:

1. Routine preventive maintenance schedule.
2. Lists of special tools, maintenance materials, and replacement parts.
3. Repair instructions for procedures to check, repair, and test equipment during typical malfunctions.
4. Recommended cleaning methods, frequency, and materials.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.
- B. Installer Qualifications: Company certified by the manufacturer and specializing in installation of networked lighting control products with minimum three years documented experience.
- C. System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation

1.9 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 1. Ambient temperature: 32 to 104°F (0 to 40°C).
 2. Relative humidity: Maximum 90%, non-condensing.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 1. Occupancy Sensors: 1 for every 10 of each type installed. Furnish at least 1 of each type installed.
 2. Wall Switches: 1 for every 10 of each type and finish installed. Furnish at least 1 of each type and finished installed.

1.11 MAINTENANCE MATERIALS

- A. Furnish one wireless configuration tool.

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1.12 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: WattStopper LMCP Series lighting control panel
- B. Approved Equals:
1. Lutron
 2. Hubbell
 3. nLight

2.2 ON/OFF/0-10V DIGITAL LIGHTING RELAY CONTROL PANEL

- A. Provide LMCP lighting control panels with On/Off relays and 0-10V control capability in the locations and capacities as indicated on the Drawings and Digital Lighting Relay Control Schedules. Each panel shall be of modular construction and consist of the following components:
1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 – 8, 1 – 24, or 1 – 48 relays and 0-10V dimming outputs. 24 and 48 size panels shall also have space for up to 6 four-pole contactors.
 2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. LMCP-10V panel cover shall have a hinged and lockable door to restrict access to line voltage section of the panel.
 3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. Interior construction shall provide isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. Interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, individually replaceable latching type relays. For each relay a 0-10V output shall be available on the relay driver board. Panel interiors shall include the following features:
 - a. Removable, plug-in terminal blocks with connections for all 0-10V wiring terminations.
 - b. Override pushbutton (providing On/Off and Dimming capability) and LED ON/OFF status for each relay.
 - c. Digital inputs (four RJ-45 jacks) shall support all Wired DLM digital switches, dimmers, input and/or output modules, daylighting sensors; occupancy sensors, and additional load controllers. Inputs are divided into two separate digital networks (A and B), each capable of supplying 250mA to connected devices.
 - d. Relay and 0-10V output states shall be available to external control devices and systems via BACnet.
 - e. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large groups of loads are to be controlled together.
 - f. Group and pattern control of relays shall be provided through a simple interface from a handheld IR programmer. Each relay and 0-10V output can be associated with a group for direct on/off or dimming control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
 - g. Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
 4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
 - a. Electrical:
 - 1) 30-amp ballast at 277V
 - 2) 16-amp E-Ballast at 120V
 - 3) 10-amp E-Ballast at 277V
 - 4) 20-amp tungsten at 120V
 - 5) 1.5 HP motor at 120V
 - 6) 20 amp at 120V for Receptacle Loads

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- 7) 14,000-amp short circuit current rating (SCCR) at 277V
 - 8) Relays shall be UL 20 listed for control of plug loads
 - b. Mechanical:
 - 1) Replaceable, 1/2" KO mounting with Class 2 wire harness and single 5-pin phenolic connector.
 - 2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
 - 3) Dual line and load terminals each support two #12 - #14 solid or stranded conductors.
 - 4) Capable of to 300,000 mechanical on/off cycles.
 - 5) Internal ferrite to prevent electrical noise on low voltage wires
 - 6) Isolated low voltage contacts provide for relay status feedback and pilot light indication
5. A 0-10V output shall be provided per relay. This output is linked to its individual relay, so they are controlled together automatically. The 0-10V signal from the panel shall meet requirements of NEMA ANSI C82.11-2011 - Annex A allowing it to control any fixtures providing a 0-10V control signal such that 10V or higher will drive the light to maximum, and 1V or less will drive the light to minimum output. A linear dimming curve is used between these levels.
6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic bypass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700. Additionally, Relay Driver Cards providing 0-10V control shall automatically open up the 0-10V single on loss of normal power, ensuring any controlled fixture powered by a different source shall go full on.
8. Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.
 - a. Each panel shall include digital clock capability able to issue system wide automation commands to up to 11 other panels for a total of 12 networked lighting control panels. Clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
 - b. Clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
 - c. Clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery backup for clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
 - d. Clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
 - 1) Scheduled ON (or Goto Level) / OFF
 - 2) Manual ON / Scheduled OFF
 - 3) Astro ON / OFF (or Photo ON / OFF)
 - 4) Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
 - e. User interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100-2) or Front End System Software package.
 - f. Clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
 - g. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
9. Lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a front end network controller, via the room to room segment network.
10. Lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices by incorporating a digital Wired Network Bridge on the panel's intelligence board. All features associated with the LMBC-300 Wired Network Bridge shall extend to the panel and its controlled loads, and all devices connected to the panel by Cat 5e local IRB network. Digital communications shall be RS485 MS/TP-based using the BACnet protocol.

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11. Wattstopper Product Number:
- 1) On/Off/0-10V Relay Panels: LMCP-8-10V, LMCP-24-10V, LMCP-48-10.
 - 2) On/Off Only Relay Panels: LMCP8, LMCP24 or LMCP48.
 - 3) Emergency Relay Option: EM-IN.

2.3 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

- A. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.
- B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity – 0-100% in 10% increments
 - b. Time delay – 1-30 minutes in 1-minute increments
 - c. Test mode – Five second time delay
 - d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 3. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time-period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - 1) Ultrasonic and Passive Infrared
 - 2) Ultrasonic or Passive Infrared
 - 3) Ultrasonic only
 - 4) Passive Infrared only
 4. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 5. One or two RJ-45 port(s) for connection to DLM local network.
 6. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 7. Device Status LEDs, which may be disabled for selected applications, including:
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 8. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 9. Manual override of controlled loads.
 10. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
- C. BACnet object information shall be available for the following objects:
1. Detection state
 2. Occupancy sensor time delay
 3. Occupancy sensor sensitivity, PIR and Ultrasonic
- D. Units shall not have any dip switches or potentiometers for field settings.
- E. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
- F. WattStopper Product Numbers:
1. Dual Technology Corner Mount:

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- a. LMDX-100
- b. Usage: Classrooms or similar spaces with ceilings
- 2. Ultrasonic Ceiling Mount:
 - a. LMUC-100
 - b. Usage: Gang toilet rooms and Corridors
- 3. Dual Technology Ceiling Mount:
 - a. LMDC-100
 - b. Usage: Offices, Conference Rooms, and similar spaces
- 4. Passive Infrared Ceiling Mount – Extended Height Lens:
 - a. LMPC-100-5
 - b. Usage: Gymnasium or other rooms with ceilings over 15' high.

G. Provide occupancy sensor quantities as shown on the Drawings.

2.4 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8-button configuration. Wall switches shall include the following features:
 - 1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 - 3. Configuration LED on each switch that blinks to indicate data transmission.
 - 4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
 - 5. Programmable control functionality including:
 - a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
 - b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
 - 6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
 - 1. Button state
 - 2. Switch lock control
 - 3. Switch lock status
- C. Two RJ-45 ports for connection to DLM local network.
- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.
- E. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
 - 1. Individual button function may be configured to Toggle, On only or Off only.
 - 2. Individual scenes may be locked to prevent unauthorized change.
 - 3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 - 4. Ramp rate may be adjusted for each dimmer switch.
- F. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
- G. WattStopper Product Numbers:
 - 1. Single Button Dimmer – LMDM-101
 - 2. Single Button – LMSW-101
 - 3. Two Button – LMSW-102

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4. Three Button – LMSW-103
5. Four Button – LMSW-104
6. Five Button with Raise/Lower – LMSW-105
7. Eight Button – LMSW-108

- H. Color:
1. Match device color in Section 262726.
 2. Match wall plate type/color in Section 262726.
- I. Provide digital wall switch quantities as shown on the Drawings.

2.5 EXTERIOR DAYLIGHT SENSORS

- A. Calibrated with independent turn-on and turn-off thresholds; minimum 2 foot-candles difference between the turn-on and turn-off thresholds.
- B. Enclosed in weatherproof housing with shading and lens protection visor.
- C. Provide one exterior daylight sensor Wattstopper Model LMIO-301 with LMPO-200 located on an exterior wall facing north.

2.6 PRE-TERMINATED PATCH CABLES

- A. Provide pre-terminated plenum rated patch cables as required for the project.
- B. WattStopper Product Number: LMRJ-PXX
- C. Provide quantities as required.

2.7 HANDHELD CONFIGURATIONS TOOLS

- A. A wireless configuration tool facilitates optional customization of DLM local networks using two-way infrared communications, while PC software connects to each local network via a USB interface.
- B. Features and functionality of the wireless configuration tool shall include but not be limited to:
1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30'.
 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
 3. Must be able to read and modify parameters for room controllers, occupancy sensors, wall switches, daylighting sensors, network bridges and relay panels, and identify room devices by type and serial number.
 4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.
 5. Temporarily adjust light level of any load(s) on the local network and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
 6. Adjust or fine-tune daylighting settings established during auto-configuration and input light level data to complete configuration of open loop daylighting controls.
 7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
 8. Verify status of building level network devices.
- C. WattStopper Product Number: LMCT-100-2
- D. Provide (1) one for the building.

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PART 3 - EXECUTION

3.1 PRE-INSTALLATION MEETING

- A. The Contractor is responsible to arrange a pre-installation meeting with manufacturer's factory authorized representative, electrical contractor and building owner representatives.
- B. The pre-installation meeting shall be scheduled prior to the rough-in of equipment. The Contractor shall notify attendees a minimum of 30 days prior to the installation to schedule meeting.
- C. The following shall be discussed during the pre-installation meeting:
 - 1. Review submittal package.
 - 2. Brief overview of system being installed and programming features.
 - 3. Programming criteria including time schedules, time delays, switch operation, and building management interface.
 - 4. Specific criteria for each space.

3.2 INSTALLATION

- A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.
- B. Install all room/area devices using manufacturer's factory-tested Category 5e cable with pre-terminated RJ-45 connectors.
 - 1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
 - 2. Low voltage wiring topology must comply with manufacturer's specifications.
 - 3. All Category cabling shall comply with Section 271500 or 271501 requirements.
 - 4. Document final wiring location, routing, and topology on as built drawings.
- C. All line voltage connections shall be tagged to indicate circuit and switched legs.
- D. Test all devices to ensure proper communication.
- E. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.
- F. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)
- G. Post start-up tuning – Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy. Provide a detailed report to the Architect / Owner of post start-up activity.
- H. Tighten all panel Class I conductors from both circuit breaker and to loads to torque ratings as marked on enclosure UL label.
- I. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.
- J. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.
- K. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.
- L. Wiring Methods:

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1. Wire Routing: Route wiring from each device up into accessible ceiling cavity within recessed metallic conduit. Stub all conduits into accessible ceiling cavity and provide bushing for each.
2. Cable Routing: Route wiring within accessible ceiling cavities. Install cable supports at 4' spacing maximum or in cable tray where applicable. No cabling is to lie on or attach to ceiling tile, ducts, pipes, conduits or ceiling suspension wires, rods, or structural members. Provide conduit stubs from devices and panels to the ceiling cavities.
3. Route all system wiring from system equipment within metallic conduit up into nearby ceiling cavity and connect to the wiring system indicated above. Provide bushings at conduit ends.
4. Provide raceways for all cabling in open structure spaces.

3.3 FACTORY COMMISSIONING

- A. WattStopper Product Number: SCOM
- B. Provide manufacturers factory-trained technician to verify that all system hardware is installed and configured in accordance with the project requirements. These services test and verify the systems are operating as intended, implement a sequence of operations, and provide a basic starting program configuration.

3.4 TRAINING

- A. WattStopper Product Number: STRAIN
- B. Personnel Training: Provide and pay for the services of a factory-authorized service representative to demonstrate the system and train Owners' personnel.
 1. Provide training for operating, testing, troubleshooting and general maintenance of the system.
 2. Manufacturer shall include training required for the equipment provided.
 3. Provide documentation of sessions to Architect/Engineer with signatures of at least 3 Owners Representatives present at demonstration.

END OF SECTION 260943

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SECTION 262200 – LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Dry Type Energy Efficient Transformers

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NEMA ST 20 - Dry Type Transformers for General Applications
- C. NETA-ATS - Acceptance Testing Specification for Electrical Power Distribution Equipment (International Electrical Testing Association)
- D. 2016 DOE Standards – Energy Efficient Transformers

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate voltage, kva, test reports, impedance rating, tap configuration, dimensions, insulation, and rated temperature rise with specific items or model numbers highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of transformers in project record documents.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by UL or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect, and handle products to site.

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- B. Deliver transformers individually wrapped for protection and mounted on shipping skids.
- C. Accept transformers on site. Inspect for damage.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.8 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 ENERGY EFFICIENT TRANSFORMERS

- A. Manufacturers:
 - 1. Square D Company
 - 2. Eaton
 - 3. Siemens
- B. Description: NEMA ST 20, factory-assembled, air cooled dry type transformers, ratings as indicated on the drawings. Transformers using cooling fans to reduce size are not acceptable.
- C. Efficiency: Transformers shall be low loss type with minimum efficiencies per DOE Standard – Energy Efficient Transformers, when operated at 35% of full load capacity.
 - 1. Transformers shall meet the 2016 Energy Code Requirements.
- D. Insulation system and average winding temperature rise for rated KVA as follows:
 - 1. 1-15 KVA: Class 185 with 115°C rise.
 - 2. 16-500 KVA: Class 220 with 150°C rise.
 - 3. 500 KVA and Larger: Class 220 with 150° rise.
- E. Case temperature: Not to exceed 35°C rise above ambient at warmest point.
- F. Winding Taps:
 - 1. Transformers Less than 15 KVA: Two 5% below rated voltage, full capacity taps on primary winding.
 - 2. Transformers 25 KVA and larger shall have a minimum of 4 – 2-1.2% full capacity primary taps (2+2-).
 - 3. Transformers 15 KVA and Larger: NEMA ST 20.
- G. Sound Levels: NEMA ST 20.
- H. Basic Impulse Level: 10 KV.
- I. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- J. Mounting:
 - 1. 1-15 kVA: Suitable for wall mounting.
 - 2. 16-75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 3. Larger than 75 kVA: Suitable for floor or trapeze mounting.
- K. Coil Conductors: Continuous windings with terminations brazed or welded.

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- L. Enclosure: NEMA ST 20; Type 1. For indoor use, Type 3R ventilated for outdoor use. Provide lifting eyes or brackets.
- M. Isolate core and coil from enclosure using vibration-absorbing mounts.
- N. Nameplate: Include transformer connection data.

2.2 IDENTIFICATION

- A. Transformer Engraved Plastic Nameplates: Engraving stock, melamine plastic laminate, minimum 1/16" thick for nameplates up to 20 sq.in. and 1/8" thick for larger sizes.
 - 1. Engraved legend shall be black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
- B. Fasteners for Nameplates: Self-tapping, stainless-steel screws, or #10/32 stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are suitable for installing transformer supports.

3.2 PREPARATION

- A. Provide 4" high concrete housekeeping pad for each floor mounted transformer.

3.3 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Set transformer plumb and level.
- C. Use flexible conduit, under the provisions of Section 260533, for connections to transformer case. Make conduit connections to side panel of enclosure.
- D. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- E. Provide grounding and bonding in accordance with Section 260526.
- F. Mount wall mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.
- G. Provide unit substation transformer mounting where shown as a switchgear lineup.
- H. Provide engraved plastic nameplates for each transformer with 1/2" high lettering. Label shall include the following:
 - 1. Transformer Name
 - 2. Phase
 - 3. Primary Voltage
 - 4. Secondary Voltage

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3.4 FIELD QUALITY CONTROL

- A. Provide field inspection, testing, adjusting as required.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.2.
- D. Test insulation resistance in accordance with NETA-ATS specifications for dry type transformers.
- E. Provide production testing of each unit in accordance with NEMA ST20.

3.5 ADJUSTING

- A. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION 262200

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SECTION 262412 – EXISTING SWITCHBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Existing Switchboards Equipment

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code
- B. ANSI/NFPA 70B – Electrical Equipment Maintenance
- C. ANSI/NFPA 70E – Standard for Electrical Safety in the Workplace
- D. NECA 400 – Standard for Installing and Maintaining Switchboards
- E. ANSI/IEEE C12.6 – Solid State for Electricity Metering
- F. ANSI C57.13 – Standard Requirements for Instrument Transformers
- G. NEMA AB 1 – Molded Case Circuit Breakers and Molded Case Switches
- H. NEMA EI 21.1 – Instrument Transformers for Revenue Metering (110 kV BIL and Less)
- I. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches
- J. NEMA PB 2 – Deadfront Distribution Switchboards, File E8681
- K. NEMA PB 2.1 – General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Switchboards Rated 600 Volts or Less
- L. NEMA PB 2.2 – Application Guide for Ground Fault Protective Devices for Equipment
- M. UL 50 – Cabinets and Boxes
- N. UL 98 – Standard for Enclosed and Dead Front Switches
- O. UL 489 – Standard for Molded Case Circuit Breakers and Circuit Breaker Enclosures
- P. UL 891 – Standard for Dead-Front Switchboards
- Q. UL 943 – Standard for Ground Fault Circuit Interrupters
- R. UL 977 – Standard for Fused Power Circuit Devices
- S. UL 1283 – Standard for Safety for Electro Magnetic Interference Filters
- T. UL 1449 – Standard for Surge Protective Devices
- U. Federal Specification W-C-375B/Gen – Circuit Breakers, Molded Case, Branch Circuit, and Service
- V. Federal Specification W-C-870 – Fuseholders (for plug and enclosed cartridge fuses)

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W. Federal Specification W-S-865 – Enclosed Knife Switch

1.3 SUBMITTALS FOR REVIEW

A. Submit under provisions of Section 260010.

B. Shop Drawings: The following items shall be submitted for review and approval:

1. Submittal booklet to include the following:

- a. Reference to Specification Section.
- b. A list of all equipment to be provided and installed.
- c. Data sheets to indicate circuit breakers and short circuit rating, with specific items or model numbers highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

A. Submit under provisions of Section 260010.

B. Record actual branch circuit arrangement.

C. Submit record copy of all testing performed.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by UL or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products in conformance with manufacturer's recommended practices as outlined in applicable Installation and Maintenance manuals.

1.8 WARRANTY

A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Match existing manufacturer

2.2 GENERAL REQUIREMENTS FOR ADDITIONAL SWITCHBOARDS DISTRIBUTION SECTIONS

A. Nominal System Voltage: Match existing.

B. Main Bus: Refer to the Switchboard Schedules or Power Riser Diagram.

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- C. Short Circuit Current Rating: Match existing.
 - D. Front Covers and Doors:
 - 1. Front covers shall be screw removable with a single tool.
 - 2. All doors shall be hinged with removable hinge pins.
 - E. Buses and Connections: Three phase, four wire, unless otherwise indicated. Provide hard-drawn plated copper of 98 percent conductivity.
 - 1. Group-Mounted Feeder Vertical Bus Stack:
 - a. Bus stack shall be capable of mounting feeder breakers with different frame sizes and number of poles across from one another on the bus stack.
 - b. Non-conducting surface films shall be removed during circuit breaker installation by a wiping action of the circuit breaker jaws.
 - c. The design of the circuit breaker jaws and bus stack shall create blow-on forces under fault conditions.
 - d. Bolted lap joint connections for feeder breakers shall not be allowed for group-mounted feeders.
 - 2. Ground Bus: Size per current NEC and UL 891 Tables 28.1 and 28.2, hard-drawn copper of 98 percent conductivity, equipped with pressure 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.
 - 3. Bus Composition: Tin plated copper. Plating shall be applied continuously to bus work. The switchboard bussing shall be of sufficient cross-sectional area to meet UL 891 temperature rise requirements. The phase and neutral through-bus shall have an ampacity as shown on the Drawings. For four-wire systems, the neutral shall be of equivalent ampacity as the phase bus bar. Tapered bus is not permitted. Full provisions for the addition of future sections shall be provided. Bussing shall include, but shall not be limited to, necessary hardware to accommodate splicing for future additions.
 - F. Future Provisions: All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
 - G. Accessibility: Accessible from the front only of the switchboard.
 - H. Provide manufacture start-up and training when required for the equipment provided.
- 2.3 DISTRIBUTION SECTION DEVICES FOR SWITCHBOARDS & ADDITIONAL BREAKERS
- A. Minimum integrated short circuit rating: Match existing.
 - B. General:
 - 1. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the associated Switchboard Schedules.
 - 2. Circuit breaker(s) shall be a group mounted plug-on with mechanical restraint on a common pan or rail assembly.
 - 3. The interior shall have 3 flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
 - 4. Circuit breaker(s) equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breaker(s) shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breaker(s) of different frame sizes shall be capable of being mounted across from each other.
 - 5. Line-side circuit breaker connections are to be jaw type.
 - 6. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
 - 7. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with a common trip handle for each pole.
 - 8. Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
 - 9. Provide circuit breakers UL listed as Type SWD for lighting circuits.
 - 10. Provide circuit breakers UL listed as Type HACR for heating, air conditioning and refrigeration equipment branch circuits.

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11. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
12. There shall be two forms of visible trip indication.
13. The exposed faceplates of all branch circuit breakers shall be flush with one another.
14. Lugs shall be UL Listed to accept solid or stranded conductors.
15. Breaker Accessories: Provide when indicated on the Panel Schedules.
 - a. Shunt Trip
 - b. Auxiliary Switch
 - c. Alarm Switch
 - d. Ground Fault – Personal Protection (6-mA trip)
 - e. Ground Fault – Equipment Protection (30-mA trip)
 - f. Handle lock
 - g. Zone Selective Interlocking

C. Breaker Types:

1. Thermal Magnetic Circuit Breaker (TM)
 - a. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
 - b. Circuit breakers shall be high interrupting or extra high interrupting.
2. Electronic Trip Circuit Breaker with Long Time, Short Time, Instantaneous Setting Adjustments (E)
 - a. All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable).
 - b. Circuit breaker trip system shall be a microprocessor-based true rms sensing designed with sensing accuracy through the 13th harmonic.
 - c. Long time pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
3. Electronic Trip Circuit Breakers with real time metering (EP)
 - a. All electronic trip circuit breaker requirements.
 - b. Current (phases, neutral, average, maximum)
 - c. Voltage (phase-to-phase, phase-to-neutral, average, unbalance)
 - d. Power (active kW, reactive kVAR, apparent kVA, power factor)
 - e. Energy (active kWh, reactive kVAR, apparent kVA)
 - f. Frequency
 - g. Total harmonic distortion (current, voltage)
 - h. Metering accuracy shall be 1.5% current (above 600 amperes), 1.0% current (600 amperes and below), 0.5% voltage, and 2% energy. This accuracy shall be total system, including, but not limited to, CT and meter.
4. Mission Critical Circuit Breaker (M)
 - a. All electronic trip circuit breaker requirements.
 - b. Oversized frame size:
 - 1) Minimum frame size of 400A for any breaker below 250A.
 - 2) Minimum frame size of 600A for any breaker between 300A-400A.
 - c. Delivers high levels of selective coordination for overcurrent tripping with previously tested combinations of downstream breaker types.
 - d. Breakers must be listed to coordinate with the provided downstream breaker types installed in the downstream panels.
5. Provide electronic trip type if not indicated on the Switchboard Schedules, Power Riser Diagram, or other drawings.

- D. Provide appropriate connectors and mounting hardware as required for the added breakers.

2.4 IDENTIFICATION

- A. Feeder overcurrent device engraved plastic nameplates: Engraving stock, melamine plastic laminate, minimum 1/16" thick for nameplates up to 20 sq. in. and 1/8" thick for larger sizes.
1. Engraved legend shall match existing or be black letters on white face.
 2. Punched or drilled for mechanical fasteners.

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- B. Fasteners for Nameplates: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surface is suitable for the additional switchboard section installation.
- B. All manufactures must verify that the equipment will fit in the space provided.

3.2 PREPARATION

- A. Provide 4" concrete housekeeping pad for each additional switchboard section.

3.3 INSTALLATION

- A. Torque all bolted connections and mechanical fasteners after placing switchboard per manufacturer's specifications.
- B. Provide appropriate bus extension kits and mounting hardware as required for adding breakers and install breakers per manufacturers requirements.
- C. Provide breaker closures for removed breakers and unused spaces in switchboards.
- D. Provide mechanically fastened engraved laminated plastic nameplates with 1/2" high lettering for each feeder overcurrent device with description of load. Also provide nameplates for spare breakers and available spaces.
- E. Provide permanently fastened pad-lockable hasp accessories which prevent circuit breaker handles from being manually moved from the OFF position for all transformer primary feeders.
- F. Ground and bond switchboard enclosure in accordance with Section 260526.
- G. Contractor is responsible for any equipment that needs to be disassembled and reassembled to get into the location specified on the drawings.
- H. Contractor is responsible for any door frames that need to be removed and reinstalled to get into the location specified on the drawings.

3.4 FIELD QUALITY CONTROL

- A. Perform field inspection and testing.
- B. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections.
- C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.
- D. Apply ANSI 61 (or other appropriate color paint) as needed.

3.5 ADJUSTING

- A. Adjust all operating mechanisms for free mechanical movement per manufacturer's specifications.

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- B. Tighten bolted bus connections in accordance with manufacturer's instructions.
- C. Provide Coordination Study to achieve required settings for adjustment. Verify equipment can be adjusted to meet the study requirements before releasing for production.
- D. Provide Fault Current Study to achieve AIC ratings for panelboards. Verify equipment meets the requirements of the study before releasing for production.
- E. Adjust circuit breaker trip and time delay settings to values indicated in the Coordination Study.

3.6 CLEANING

- A. Upon completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots, dirt, and debris from interior and exterior of switchboards.
- B. Touch up scratched or marred surfaces to match original finish.

3.7 SETUP/TRAINING

- A. Manufacturers Setup: Provide and pay for the services of a factory-authorized service representative to start-up, set-up, and train the Owner for the equipment provided.

END OF SECTION 262412

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SECTION 262416 – PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Distribution Panelboards
- B. Branch Circuit Panelboards
- C. Integral Equipment

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code
- B. NEMA PB 1 – Panelboards
- C. NEMA PB 1.1 – General Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less
- D. NEMA AB 1 – Molded Case Circuit Breakers and Molded Case Switches
- E. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- F. UL 50 – Enclosures for Electrical Equipment
- G. UL 67 – Panelboards
- H. UL 98 – Enclosed and Dead-Front Switches
- I. UL 489 – Molded – Case Circuit Breakers and Circuit Breaker Enclosures
- J. UL 1449, Edition 4 – Standard for Surge Protective Devices
- K. Federal Specification W-P115C – Type 1, Class 1
- L. Federal Specification W-C-375B/Gen – Circuit Breakers, Molded Case, Branch Circuit, and Service
- M. Federal Specification W-C-37B – Molded Case Circuit Breakers
- N. ASTM – American Society of Testing Materials

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.

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- c. Data sheets to indicate voltage, main bus ampacity, circuit breakers, short circuit rating with specific items or model numbers highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of Products; indicate actual branch circuit arrangement.
- C. Submit record copy of all testing performed.
- D. Provide a copy of the approved Panel Schedules included in the O&M Manuals.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing of panelboards specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by UL or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.
- C. Provide UL service entrance equipment on all units used as service entrance equipment.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inspect and report concealed damage to carrier within their required time-period.
- B. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.
- C. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris and traffic.

1.8 MAINTENANCE MATERIALS

- A. Provide two keys for each panelboard installed.

1.9 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Square D Company

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- B. Alternate manufacturers as listed below:
 - 1. Eaton
 - 2. Siemens
- C. Alternate manufacturers subject to compliance with the following requirements:
 - 1. The dimensions of the alternate manufacturer will fit in the proposed location and that all required clearances per NEC, Access and Maintenance are maintained.
 - a. The performance and operating characteristics meet or exceed the Basis of Design.
 - b. The alternate manufacturer shall include all features, accessories and additional equipment required for a complete installation.

2.2 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Ground Bus: Provide copper ground bus in enclosures and bond the bus to the enclosure.
- B. Neutral Bus: Provide copper insulated neutral bus in all enclosures where the feeder circuit contains a neutral conductor. Bond the neutral bus to the ground bus or enclosure when the enclosure contains the service main disconnect or the disconnect at a building which receives its power from a service in another building. Provide bus with current carrying capacity of 100% except where otherwise indicated.
- C. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- D. Ground Fault Systems: Provide ground fault systems and on-site testing per NEC Article 230 for panelboards with main service disconnect switch.
- E. Load Side Terminations: Provide lugs on circuit breakers of sufficient size to terminate conductors scheduled or indicated on plans.
- F. Use only Owner-assigned room names/numbers in final Panel Schedules.
- G. For recessed double panels, allow at least 4" between backboxes so that trim does not butt or overlap.
- H. Provide 2 – 100% neutral assemblies in all split bus panelboards.
- I. Provide "Hinged Trim" panelboard covers for all distribution and branch circuit panelboards. The entire trim shall be hinged to swing to one side of the box to access the panel gutter space.
- J. All Panelboards with greater than 42 poles shall have 2 panel backboxes. Single backboxes with more than 42 poles will be unacceptable.
- K. Provide manufacture start-up and training when required for the equipment provided.

2.3 PANELBOARD SHORT CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
- B. Fully rated to interrupt symmetrical short-circuit current available at terminals.
- C. Manufacturers option unless noted otherwise on the Panel Schedules or Power Riser Diagram.

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2.4 DISTRIBUTION PANELBOARDS (600A AND ABOVE)

- A. Panelboards: NEMA PB 1, circuit breaker type suitable for use as service entrance equipment.
- B. Interior:
 - 1. Panelboard Bus: Copper, (silver plated copper, or tin-plated copper) ratings as indicated.
 - a. Provide copper ground bus in each panelboard.
 - 2. Provide one (1) continuous bus bar per phase.
 - a. Each bus bar shall have sequentially phased branch circuit connectors suitable bolt-on branch circuit breakers.
 - b. The bussing shall be fully rated.
 - c. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
 - 3. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
 - 4. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
 - 5. A solidly bonded copper equipment ground bar shall be provided.
 - 6. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have filler plates covering unused mounting spaces.
- C. Minimum Integrated Short Circuit Rating:
 - 1. Amperes Interrupting Current (AIC) Ratings: 120V, 208V, and 240V breaker – minimum AIC 10,000 amps unless otherwise noted on the Panel Schedules.
 - 2. Amperes Interrupting Current (AIC) Ratings: 277V and 480V breaker – minimum AIC 14,000 amps unless otherwise noted on the Panel Schedules.
- D. Main Circuit Breaker:
 - 1. Electronic trip molded case standard function 80% rated circuit breaker. Provide 100% when indicated on the Panel Schedules.
 - 2. All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments. Provide Ground Fault Pickup and Ground Fault Delay when indicated on the Panel Schedules.
 - 3. Circuit breaker trip system shall be a microprocessor-based true rms sensing designed with sensing accuracy through the 13th harmonic.
 - 4. Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
 - 5. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.
 - 6. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
 - 7. Lugs shall be UL Listed to accept solid or stranded conductors.
 - 8. Breaker Accessories: Provide when indicated on the Panel Schedules.
 - a. Shunt Trip
 - b. Under Voltage Trip
 - c. Ground Fault Shunt Trip
 - d. Auxiliary Switch
 - e. Alarm Switch
 - f. Mechanical Lug Kits
 - g. Compression Lug Kits
 - h. Handle Lock
 - i. Zone Selective Interlocking
- E. Branch Circuit Breakers:
 - 1. General:
 - a. Circuit breakers shall be 80% rated unless otherwise indicated on the Panel Schedules.

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- b. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the associated panel schedules.
 - c. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with a common trip handle for each pole.
 - d. Provide circuit breakers UL listed as Type SWD for lighting circuits.
 - e. Provide circuit breakers UL listed as Type HACR for heating, air conditioning and refrigeration equipment branch circuits.
 - f. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
 - g. There shall be two forms of visible trip indication.
 - h. The exposed faceplates of all branch circuit breakers shall be flush with one another.
 - i. Lugs shall be UL Listed to accept solid or stranded conductors.
 - j. Breaker Accessories: Provide when indicated on the Panel Schedules.
 - 1) Shunt Trip
 - 2) Auxiliary Switch
 - 3) Alarm Switch
 - 4) Ground Fault – Personal Protection (6-mA trip)
 - 5) Ground Fault – Equipment Protection (30-mA trip)
 - 6) Handle lock
 - 7) Zone Selective Interlocking
2. Breaker Types:
- a. Thermal Magnetic Circuit Breaker (TM):
 - 1) Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
 - b. Electronic Trip Circuit Breaker with Long Time, Short Time, Instantaneous Setting Adjustments (E)
 - 1) All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable).
 - 2) Circuit breaker trip system shall be a microprocessor-based true rms sensing designed with sensing accuracy through the 13th harmonic.
 - 3) Long time pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
 - c. Electronic Trip Circuit Breakers with real time metering (EP)
 - 1) All electronic trip circuit breaker requirements.
 - 2) Current (phases, neutral, average, maximum)
 - 3) Voltage (phase-to-phase, phase-to-neutral, average, unbalance)
 - 4) Power (active kW, reactive kVAR, apparent kVA, power factor)
 - 5) Energy (active kWh, reactive kVAR, apparent kVA)
 - 6) Frequency
 - 7) Total harmonic distortion (current, voltage)
 - 8) Metering accuracy shall be 1.5% current (above 600 amperes), 1.0% current (600 amperes and below), 0.5% voltage, and 2% energy. This accuracy shall be total system, including, but not limited to, CT and meter.
 - d. Mission Critical Circuit Breaker (M)
 - 1) All electronic trip circuit breaker requirements.
 - 2) Oversized frame size:
 - a) Minimum frame size of 400A for any breaker below 250A.
 - b) Minimum frame size of 600A for any breaker between 300A-400A.
 - 3) Delivers high levels of selective coordination for overcurrent tripping with previously tested combinations of downstream breaker types.
 - 4) Breakers must be listed to coordinate with the provided downstream breaker types installed in the downstream panels.
 - e. Provide electronic trip type if not indicated on the Panel Schedules.

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- F. Enclosure: NEMA PB 1:
1. Interior Locations: Type 1
 - a. Type 1 Boxes:
 - 1) Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvanized steel is not acceptable.
 - 2) Boxes shall have removable blank end walls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.
 - b. Type 1 Cabinet Front:
 - 1) Front shall meet strength and rigidity requirements per UL 50 Standards. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
 - 2) Trim front shall be hinged 1-piece with door or door in door. Mounting shall be flush, or surface as indicated.
 - 3) Trim front door shall have rounded corners and edges free of burrs.
 - 4) A clear plastic directory cardholder shall be mounted on the inside of the door.
 - 5) Locks shall be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.
 - 6) A clear plastic directory cardholder shall be mounted on the inside of door.
 2. Exterior Locations: Type 3R:
 - a. Type 3R Boxes:
 - 1) Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
 - b. Type 3R Cabinet Front:
 - 1) All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners on enclosures 59" or more in height.
 - 2) All lock assemblies shall be keyed alike.
 - 3) One (1) key shall be provided with each lock.
 - 4) A clear plastic directory cardholder shall be mounted on the inside of door.
- G. Panel Skirts:
1. 3-Sided with open back:
 - a. Sheet metal to cover conduits above and/or below a standard panelboard box when the panelboard is located against a wall. Sheet metal shall be same gauge and finish as panelboard and equipped with mounting flanges.
 2. 4-Sided:
 - a. Sheet metal to cover conduits above and/or below a standard panelboard box when the panelboard is located at the center of the room/area. Sheet metal shall be same gauge and finish as panelboard and equipped with mounting flanges.
 3. Provide when indicated on the Panel Schedules.

2.5 BRANCH CIRCUIT PANELBOARDS

- A. Lighting and Appliance Branch Circuit Panelboards: NEMA PB1, circuit breaker type.
- B. Interior:
1. Panelboard Bus: Copper, ratings as indicated.
 - a. Provide copper ground bus in each panelboard.
 2. Provide one (1) continuous bus bar per phase.
 - a. Each bus bar shall have sequentially phased branch circuit connectors suitable for bolt-on branch circuit breakers.
 - b. The bussing shall be fully rated.
 - c. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
 3. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
 4. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.

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5. A solidly bonded copper equipment ground bar shall be provided.
 6. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have filler plates covering unused mounting spaces.
- C. Minimum Integrated Short Circuit Rating:
1. Amperes Interrupting Current (AIC) Ratings: 120V, 208V, and 240V breaker – minimum AIC 10,000 amps unless otherwise noted on the Panel Schedules.
 2. Amperes Interrupting Current (AIC) Ratings: 277V and 480V breaker – minimum AIC 14,000 amps unless otherwise noted on the Panel Schedules.
- D. Main Circuit Breaker:
1. Electronic trip molded case standard function 80% rated circuit breaker. Provide 100% when indicated on the Panel Schedules.
 2. All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments. Provide Ground Fault Pickup and Ground Fault Delay when indicated on the Panel Schedules.
 3. Circuit breaker trip system shall be a microprocessor-based true rms sensing designed with sensing accuracy through the 13th harmonic.
 4. Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
 5. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.
 6. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
 7. Lugs shall be UL Listed to accept solid or stranded conductors.
 8. Breaker Accessories: Provide when indicated on the Panel Schedules.
 - a. Shunt Trip
 - b. Under Voltage Trip
 - c. Ground Fault Shunt Trip
 - d. Auxiliary Switch
 - e. Alarm Switch
 - f. Mechanical Lug Kits
 - g. Compression Lug Kits
 - h. Handle Lock
 - i. Zone Selective Interlocking
- E. Branch Circuit Breakers:
1. Circuit breakers shall be 80% rated unless otherwise indicated on the Panel Schedules.
 2. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the associated panel schedules.
 3. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with a common trip handle for each pole.
 4. Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
 5. Provide circuit breakers UL listed as Type SWD for lighting circuits.
 6. Provide circuit breakers UL listed as Type HACR for heating, air conditioning, and refrigeration equipment branch circuits.
 7. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
 8. There shall be two forms of visible trip indication.
 9. The exposed faceplates of all branch circuit breakers shall be flush with one another.
 10. Lugs shall be UL Listed to accept solid or stranded conductors.
 11. Breaker Accessories: Provide when indicated on the Panel Schedules.
 - a. Shunt Trip
 - b. Auxiliary Switch
 - c. Alarm Switch
 - d. Ground Fault – Personal Protection (6-mA trip)
 - e. Ground Fault – Equipment Protection (30-mA trip)

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- f. Arc-Fault Circuit Interrupter
- g. Handle lock

F. Enclosure: NEMA PB 1:

1. Interior Locations: Type 1:

a. Type 1 Boxes:

- 1) Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvanized steel is not acceptable.
- 2) Boxes shall have removable endwalls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.

b. Type 1 Cabinet Front:

- 1) Front shall meet strength and rigidity requirements per UL 50 Standards. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
- 2) Front shall be hinged 1-piece with door. Mounting shall be flush, or surface as indicated.
- 3) Panelboards shall have MONO-FLAT fronts with concealed door hinges and mounted with trim screws. Front shall not be removable with the door locked. Doors on front shall have rounded corners and edges shall be free of burrs.
- 4) Front shall have cylindrical tumbler type lock with catch and spring-loaded stainless-steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.
- 5) A clear plastic directory cardholder shall be mounted on the inside of door.

2. Stainless Steel Cabinet Front:

- a. 304 stainless steel hinged 1-piece with door.

3. Exterior Locations: Type 3R:

a. Type 3R Boxes:

- 1) Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

b. Type 3R Cabinet Front:

- 1) All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners on enclosures 59" or more in height.
- 2) All lock assemblies shall be keyed alike.
- 3) One (1) key shall be provided with each lock.
- 4) A clear plastic directory cardholder shall be mounted on the inside of door.

G. Panel Skirts:

1. 3-Sided with open back:

- a. Sheet metal to cover conduits above and/or below a standard panelboard box when the panelboard is located against a wall. Sheet metal shall be same gauge and finish as panelboard and equipped with mounting flanges.

2. 4-Sided:

- a. Sheet metal to cover conduits above and/or below a standard panelboard box when the panelboard is located at the center of the room/area. Sheet metal shall be same gauge and finish as panelboard and equipped with mounting flanges.

3. Provide when indicated on the Panel Schedules.

2.6 ARC ENERGY REDUCTION SWITCH (AERS)

A. Provide for 1200A and above panelboards.

B. An ARC Energy Reduction Switch shall be made available mounted internally to the panelboard for breakers required per the National Electricals Code 240.87.

C. Shall provide a Modbus TCP/IP connection to the breaker. Breaker data connection shall be available for connection to external monitoring software. Shall also provide a web page providing historical information,

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breaker status, breaker metering and maintenance data. Device shall be capable of sending breaker alarms via email and smart phone application.

2.7 CUSTOMER METERING

- A. Provide customer metering when indicated on the Panel Schedules or Power Riser Diagram.
 - 1. Manufacturers:
 - a. Square D Company Model PM5563
 - b. Eaton Model PXM 9410 Series
 - c. Siemens Model 9410 Series
 - 2. Digital Power Meter with 0.25% accuracy with the following features: A, V, kW, kVAR, kVA, PF, F kWh, kVARh, kVAh, KYZ, RS-485 Communications, Ethernet Communications THD, Demand, kWd kVARd, kVAd, date/time stamping, predicted power demand, onboard alarms, min/max readings, data log, and event log.
 - a. Onboard WEB pages to view real-time and logged information.
 - b. Connection point for Energy Management System.
 - 3. Circuit Monitor Installation:
 - a. Electronic Circuit Monitors shall be installed by the panelboard manufacturer for all circuits as indicated by the project drawings. Mount no lower than 48" and no higher than 72".
 - b. All control power, CT, PT, and communications wire shall be factory wired and harnessed within the panelboard.
 - c. Where external circuit connections are required, terminal blocks shall be provided, and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.
 - 4. Certification Description:
 - a. All equipment included as part of the power and trip history metering shall be UL listed.
 - 1) IEC 62053-23
 - 2) IEC 62052-11
- B. Provide necessary hardware to support monitoring of real-time operational data from trip units and customer meters in Panelboards.
 - 1. Hardware shall support protocol conversion from Modbus →BACNET/IP to support monitoring of data by customer BMS System.
 - 2. Hardware shall have the capability to monitor a minimum of 50 parameters from each installed trip unit via Modbus protocol and mapping these points to a common register map compatible with BACNET/IP protocol.
 - 3. Hardware shall have the capability to monitor a minimum of 20 Modbus devices concurrently.
 - 4. Hardware should be as manufactured by Sierra Montiro Protonode or approved equal.
- C. Provide Manufacturers Field Service to start-up, set-up, and train the Owner for all meters.

2.8 INTEGRATED SURGE SUPPRESSION DEVICE

- A. Provide integrated surge suppression device when indicated on the Panel Schedule or Power Riser Diagram.
- B. Integral Surge Suppressor:
 - 1. SPD shall be component recognized in accordance with UL 1449 Fourth Edition. SPD shall be installed by and shipped from the electrical distribution equipment manufacturer's factory.
 - 2. The surge protection devices shall be bus mounted. If a breaker is needed to feed the integrally mounted SPDs, provide the breaker and wiring required.
 - 3. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G in WYE Systems.
 - 4. SPD shall be constructed as a per phase or single system module design. Each mode including N-G shall be protected by internal overcurrent and thermal overtemperature controls.
 - 5. SPD shall be UL 1449 listed and labeled with 200kA Short Circuit Current Rating (SCCR).
 - 6. SPDs shall be equipped with the following diagnostics:

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- a. Visible indication of proper SPD connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable. The status of each SPD module shall be monitored on the front cover of the enclosure. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate a state change of dry contacts for testing purposes.
 - b. Audible alarm with on/off silence function and diagnostic test function (excluding branch).
 - c. Form C dry contacts
 - d. Surge Counter
 7. SPD shall be complimentary UL 1283 listed for EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.
 8. SPD shall have a warranty for a period of 10 years, incorporating unlimited replacement of suppressor parts. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.
- C. Internal Type H1 Unit: Non-Critical Load Applications:
1. Voltage Rating: 480Y/277V, 3-phase, 4-wire
 2. Application: Distribution Panelboard
 3. Minimum Modes of Protection: Common or Normal: L-N, L-G, L-L & N-G
 4. Maximum UL 1449 Voltage Protection Ratings (VPRs) for L-N, L-G, and N-G Modes of Protection: 1200 volts
 5. I-nominal Rating: 20kA
 6. Minimum Acceptable Single Pulse Surge Current Capacity: 240,000 amps per phase
 7. The following Models are acceptable:
 - a. Square D Company Model TVS41MA24
 - b. Eaton Model SPD250480Y2A
 - c. Siemens Model TPS3E0525X2, TPS3E0125X002, TPS3E0225X2
- D. Internal Type H2 Unit: Non-Critical Load Applications:
1. Voltage Rating: 480Y/277V, 3-phase, 4-wire
 2. Application: Distribution or Branch Circuit Panelboard
 3. Minimum Modes of Protection: Common or Normal: L-N, L-G, L-L, & N-G
 4. Maximum UL 1449 Voltage Protection Ratings (VPR's) for L-N, L-G, & N-G Modes of Protection: 1200 volts
 5. I-Nominal Rating: 20kA
 6. Minimum Acceptable Single Pulse Surge Current Capacity: 160,000 amps per phase
 7. The following Models are acceptable:
 - a. Square D Company Model TVS41MA16
 - b. Eaton Model SPD160480Y2A
 - c. Siemens Model TPS3E0520X2, TPS3E0120X002, TPS3E0120X2
- E. Internal Type H3 Unit: Non-Critical Load Applications:
1. Voltage Rating: 480Y/277V, 3-phase, 4-wire
 2. Application: Distribution or Branch Circuit Panelboard
 3. Minimum Modes of Protection: Common or Normal: L-N, L-G, L-L & N-G
 4. Maximum UL 1449 Voltage Protection Ratings (VPRs) for L-N, L-G, and N-G Modes of Protection: 1200 volts
 5. I-nominal Rating: 20kA
 6. Minimum Acceptable Single Pulse Surge Current Capacity: 120,000 amps per phase
 7. The following Models are acceptable:
 - a. Square D Company Model TVS41MA12
 - b. Eaton Model SPD120480Y2A
 - c. Siemens Model TPS3E0515X2, TPS3E0115X002, TPS3E0115X2
- F. Internal Type L1 Unit: Non-Critical Load Applications:
1. Voltage Rating: 208Y/120V, 3-phase, 4-wire
 2. Application: Distribution Panelboard
 3. Minimum Modes of Protection: Common or Normal: L-N, L-G, N-G
 4. Maximum UL 1449 Voltage Protection Ratings (VPRs) for L-N, L-G, and N-G Modes of Protection: 700 volts.
 5. I-nominal Rating: 20kA
 6. Minimum Acceptable Single Pulse Surge Current Capacity: 240,000 amps per phase

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7. The following Models are acceptable:
 - a. Square D Company Model TVS2IMA24
 - b. Eaton Model SPD250208Y2A
 - c. Siemens Model TPS3C0525X2, TPS3C0125X002, TPS3C0225X2

G. Internal Type L2 Unit: Non-Critical Load Applications:

1. Voltage Rating: 208Y/120V, 3-phase, 4-wire
2. Application: Distribution or Branch Circuit Panelboard
3. Minimum Modes of Protection: Common or Normal: L-N, L-G, N-G
4. Maximum UL 1449 Voltage Protection Ratings (VPRs) for L-N, L-G, and N-G Modes of Protection: 700 volts.
5. I-nominal Rating: 20kA
6. Minimum acceptable single pulse surge current capacity: 160,000 amps per phase
7. The following models are acceptable:
 - a. Square D Company Model TVS2IMA16
 - b. Eaton Model SPD160208Y2A
 - c. Siemens Model TPS3C0520X2, TPS3C0120X002, TPS3C0220X2

H. Internal Type L3 Unit: Non-Critical Load Applications:

1. Voltage Rating: 208Y/120V, 3-phase, 4-wire
2. Application: Distribution or Branch Circuit Panelboard
3. Minimum Modes of Protection: Common or Normal: L-N, L-G, N-G
4. Maximum UL 1449 Voltage Protection Ratings (VPRs) for L-N, L-G, and N-G Modes of Protection: 700 volts.
5. I-nominal Rating: 20kA
6. Minimum Acceptable Single Pulse Surge Current Capacity: 120,000 amps per phase
7. The following models are acceptable:
 - a. Square D Company Model TVS2IMA12
 - b. Eaton Model SPD120208Y2A
 - c. Siemens Model TPS3C0515X2, TPS3C0115X002, TPS3C0215X2

2.9 IDENTIFICATION

- A. Panelboard engraved plastic nameplates: Engraving stock, melamine plastic laminate, minimum 1/16" thick for nameplates up to 20 sq. in. and 1/8" thick for larger sizes.
 1. Engraved legend shall be black letters on white face.
 2. Punched or drilled for mechanical fasteners.
- B. Fasteners for Nameplates: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1, NEC Standards, Local Codes, and Manufacturer's Instructions.
- B. Install panelboards plumb.
- C. Install recessed panelboards flush with wall finishes.
- D. Provide supports in accordance with Section 260529.
- E. Mount panelboards 6'-6" to the top of enclosure.

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- F. Provide breaker closures for unused spaces in panelboards.
- G. Provide typed circuit directory for each branch circuit panelboard.
 - 1. Revise directory to reflect circuiting changes required to balance phase loads.
 - 2. Contractor to submit a copy of all panelboard directory schedules to the Owner, showing correct room name and/or number, for his approval. Contractor to make changes recommended by the Owner before final typed directories are installed in panelboards.
- H. Provide engraved plastic nameplates for each panelboard with 1/2" high lettering. Label shall include the following:
 - 1. Panel Name
 - 2. Voltage, Phase, Wire
 - 3. Location of the panel, switchboard or disconnect device which feeds the panelboard.
- I. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Minimum spare conduits: 1 empty 1" per 4 poles of spare breakers and spaces. Identify each as SPARE.
- J. Provide accessories which prevent circuit breaker handles from being manually moved from the ON position for the handles of all circuit breaker which feed emergency lighting circuits, public address and intercom systems and uninterruptable power supplies.
- K. Ground and bond panelboard enclosure in accordance with Section 260526.
- L. Provide category 6 cable in 3/4" conduit from each meter to nearest MDF/IDF and terminate on both ends unless otherwise noted.
- M. Provide a dedicated 3-pole branch circuit breaker to feed TVSS unit (only when required by manufacturer). Circuit breaker size and wire size shall be per manufacturer recommendation. Connect leads to load side of the circuit breaker.
- N. Where replacing existing panels and existing conductors are to be connected to new CB's, provide extensions of conductors as needed using same color and size of wire using a butt-splice.
- O. Contractor shall trace all circuits listed as "Existing Circuits" and provide the correct description for the circuit. Existing Circuit will not be acceptable in the Final Panel Schedules.
- P. Provide main lug only and main breaker lugs that are sized to terminate the conductors shown on the plans. Where lug sizes are not available to terminate the scheduled conductors the Electrical Contractor (EC) shall provide compression reducing pin terminals that are rated for the application. Where termination lug quantities are not available for the equipment the EC shall provide insulated termination lug sets with the quantity of conductors as needed to connect to the equipment. Conductor lengths shall be kept to a minimum and sized to meet the largest lug size and quantity available on the equipment. In no case shall the conductors be sized less than the amp rating of the circuit breaker feeding the equipment. All parallel sets of raceways, junction boxes and associated accessories shall be included.

3.2 FIELD QUALITY CONTROL

- A. Perform field inspection and testing.
- B. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections.
- C. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 10% of each other. Maintain proper phasing for multi-wire branch circuits.

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- D. Check tightness of bolted connections, and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.
- E. Test ground fault systems per NEC Article 230.
- F. Apply ANSI 61 (or other appropriate color paint) as needed.

3.3 PANEL SCHEDULES

- A. As indicated in the Specifications or Drawings.
- B. Schedules show separate wire and conduit sizes for each individual branch circuit. The Contractor may install more than one circuit in a conduit and eliminate unused conduits. The Contractor is responsible for resizing the conduits and providing derated conductors per the requirements of ANSI/NFPA 70 – National Electrical Code.

3.4 ADJUSTING

- A. Adjust all operating mechanisms for free mechanical movement per manufacturer's specifications.
- B. Tighten bolted bus connections in accordance with manufacturer's instructions.
- C. Provide Coordination Study to achieve required settings for adjustment. Verify equipment can be adjusted to meet the study requirements before releasing for production.
- D. Provide Fault Current Study to achieve AIC ratings for panelboards. Verify equipment meets the requirements of the study before releasing for production.
- E. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 10% of each other. Maintain proper phasing for multi-wire branch circuits.
- F. Adjust circuit breaker trip and time delay settings to values indicated in the Coordination Study.

3.5 CLEANING

- A. Upon completion of installation, inspect interior and exterior panelboards. Remove paint splatters and other spots, dirt, and debris from interior and exterior of panelboards.
- B. Touch up scratched or marred surfaces to match original finish.

3.6 SETUP/TRAINING

- A. Manufacturer's Setup: Provide and pay for the services of a factory-authorized service representative to start-up, set-up, and train the Owner for the equipment provided.

END OF SECTION 262416

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SECTION 262726 – WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wall Switches
- B. Wall Dimmers
- C. Receptacles
- D. Cord and Plug Sets
- E. Wall Plates
- F. Electric Cord Reels

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NECA - Standard of Installation
- C. NEMA WD 1 - General Requirements for Wiring Devices
- D. NEMA WD 6 - Wiring Device -- Dimensional Requirements
- E. UL486A & UL486B
- F. WC-596
- G. WC-896

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate voltage ratings, current rating, color and configuration with specific item and model numbers highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Submit record copy of all testing performed.

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1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Provide Products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.
- C. All devices shall meet Federal Spec WC-596 and WC-896.

1.7 COORDINATION

- A. Receptacles for General Contractor or Owner Furnished Equipment: Match plug configurations and ratings.
- B. Cord and Plug Sets: Match equipment requirements.
- C. Coordinate outlet box type and heights with Specification Sections 260010 and 260533.

1.8 EXTRA MATERIALS

- A. Furnish extra materials as described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Wall Plates: 1 for every 100 of each style, size and finish installed. Furnish at least 2 of each style, size and finish installed.
 - 2. Switches: Furnish 5 of each style, size and finish installed. None required for Indicator Switches and Wall Dimmers.
 - 3. Receptacles: Furnish 10 of each style, size and finish installed. None required for Range and Dryer receptacles.

1.9 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

- A. Single Pole Switch: 120/277V, 20A:
 - 1. Hubbell Model HBL1221X
 - 2. Leviton Model 1221-2X
 - 3. Pass & Seymour Model PS20AC1-X
 - 4. Provide 2-pole, 3-way and 4-way switches of the same series as required.
- B. Key Operated Switch, Single Pole: 120/277V, 20A:
 - 1. Hubbell Model HBL1221L
 - 2. Leviton Model 1221-2LX
 - 3. Pass & Seymour Model PS20AC1-XL
 - 4. Provide 2-pole, 3-way and 4-way switches of the same series as required.

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- C. Indicator Switch: 1P, 120/277V, 20A (Light on with load off):
 - 1. Hubbell Model HBL1221XL
 - 2. Leviton Model 1221-LHI or 1221-7LX
 - 3. Pass & Seymour Model PS20AC1-XSL
 - 4. Provide 2-pole, 3-way and 4-way switches of the same series as required.
- D. Indicator Switch: 1P, 120/277V, 20A (Light on with load on):
 - 1. Hubbell Model HBL1221PL
 - 2. Leviton Model 1221-PLI or 1221-7PX
 - 3. Pass & Seymour Model PS20AC1-XPL or PS20AC1-RPL7
 - 4. Provide 2-pole, 3-way and 4-way switches of the same series as required.
- E. Single Button Automatic Wall Switch: 120/277V, 20A:
 - 1. Watt Stopper Model DW-100
 - 2. Sensor Switch Model WSX-PDT-XX
 - 3. Leviton Model OSSMT-MDX
 - 4. Lutron Model MSX102-XX
- F. Two Button Automatic Wall Switch: 120/277V, 20A:
 - 1. Watt Stopper Model DW-200
 - 2. Sensor Switch Model WSX-PDT-2P-XX
 - 3. Leviton Model OSSMD-MDX
 - 4. Lutron Model MSX202-XX
- G. 0-10V Dimming Wall Switch Occupancy Sensor: 120/277V, 20A:
 - 1. Watt Stopper Model DW-311-X
 - 2. Hubbell Model LHDMMTS-2-N-XX
 - 3. Sensor Switch Model WSX-PDT-D-XX
- H. Digital Time Switch: 120/277V, 20A:
 - 1. Watt Stopper Model TS-400
 - 2. Sensor Switch Model PTS-60
- I. Explosion Proof Single Pole Switch: 120/277, 20A:
 - 1. Appleton Model EFS175-F1 or EFSC175-F1.
 - 2. Provide 2-pole, 3-way and 4-way switches of the same series as required.
- J. Color: Ivory unless directed otherwise by Architect.

2.2 TAMPER-RESISTANT RECEPTACLES

- A. Tamper-Resistant Duplex Receptacle: 125V, 20A:
 - 1. Hubbell Model HBL5362XTR
 - 2. Leviton Model 5362-SGX
 - 3. Pass & Seymour Model TR63-X
 - 4. Provide isolated ground and hospital grade type of the same series where indicated on the Drawings.
- B. Tamper-Resistant/Weather-Resistant GFCI Receptacle: 125V, 20A:
 - 1. Hubbell Model GFRTW20X
 - 2. Leviton Model GFWT2-X
 - 3. Pass & Seymour Model 2097TRWRX
 - 4. All GFI Receptacles shall meet the latest Standard 943 for Class A GFI Receptacles/UL 498 for receptacles.
 - 5. Provide isolated ground and hospital grade type of the same series where indicated on the Drawings.

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6. All GFI Receptacles shall be weather resistant.
- C. Tamper-Resistant Duplex Convenience Receptacle with USB Charger: 125V, 20A:
 1. Hubbell Model USB20AC5PDX or USB20CPDX
 2. Pass & Seymour Model TR20USBAC6X or TR20USBC6X
 3. Engineer's Choice on USB Type.
- D. Tamper-Resistant/Weather-Resistant GFCI Receptacle with USB Charger: 125V, 20A:
 1. Pass & Seymour Model TR20USBAC6CDW.
 2. Engineer's choice on USB type.
 3. All GFI Receptacles shall meet the latest Standard 943 for Class A GFI Receptacles/UL 498 for receptacle.
 4. All GFCI Receptacles shall be weather-resistant.
- E. Tamper-Resistant Surge Suppressor Receptacle: 125V, 20A:
 1. Hubbell Model SNAP5362XS
 2. Leviton Model T5380-X
 3. Pass & Seymour Model TR5362XSP
 4. Provide isolated ground and hospital grade type of the same series where indicated on the Drawings.
- F. Tamper-Resistant USB Charger/5V DC Output: 125V, 20A:
 1. Hubbell Model AVPS202X
- G. Color: Ivory unless directed otherwise by Architect.

2.3 RECEPTACLES

- A. Single Receptacle: 250V, 20A (NEMA 6-20R):
 1. Hubbell Model HBL5461X
 2. Leviton Model 5461-X
 3. Pass & Seymour Model 5871
 4. Provide isolated ground and hospital grade type of the same series where indicated on the Drawings.
- B. Dryer Receptacles (NEMA 14-30R):
 1. Hubbell Model RR430F
 2. Leviton Model 278
 3. Pass & Seymour Model 3864
 4. Dryer receptacles shall be complete with matching cord/plug set and a stainless-steel cover plate. (Verify location and mounting heights with Architect before roughing-in.)
- C. Color: Ivory unless directed otherwise by Architect.

2.4 CORDS

- A. Cord and Plug Sets:
 1. Description: Match voltage, current ratings, and number of conductors to requirements of equipment being connected.
 - a. Cord: Extra hard usage per NEC.
 - b. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.
- B. Pendant Cord/Connector Devices:
 1. Description: Matching, locking-type plug, and receptacle body connector, NEMA WD 6. Configurations as indicated or as required for equipment.

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- a. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
- b. 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.

2.5 WALL PLATES

- A. Super Stainless-Steel Receptacle Cover Plate: Interior Finish Walls:
 - 1. Hubbell Model SS8/SS26
 - 2. Leviton Model 84003/84401-40
 - 3. Pass & Seymour Model SS8/SS26
- B. Super Stainless-Steel Switch Cover Plate: Interior Finish Walls:
 - 1. Hubbell Model SS1
 - 2. Leviton Model 84001
 - 3. Pass & Seymour Model SS1
- C. Metal Receptacle Cover Plate: Electrical Rooms, Mechanical Rooms and Boiler Rooms:
 - 1. Cooper Crouse-Hinds Model TP516
 - 2. Appleton Model 8365N
 - 3. Steel City Model RS12
- D. Metal Switch Cover Plate: Electrical Rooms, Mechanical Rooms, and Boiler Rooms:
 - 1. Cooper Crouse-Hinds Model TP512
 - 2. Appleton Model 8361
 - 3. Steel City Model RS-9
- E. Weatherproof While In Use Cover: All exterior building mounted receptacles unless otherwise noted.
 - 1. Hubbell Model WP26E
 - 2. Leviton Model 5977-CL
 - 3. Pass & Seymour Model WIUC10-XX
 - 4. Taymac Model MX3200
 - 5. Rating shall be maintained while in use.
 - 6. Provide horizontal cover if receptacle is mounted horizontally.
- F. Provide all additional combination cover plates of the same series required for the entire project. All devices in the project shall have a cover plate.
- G. Provide all devices, outlet boxes, junction boxes, etc with the appropriate type cover plate.
- H. Provide junior or jumbo size plates as required of the same series and type for all outlets installed in masonry walls.
- I. Wiring devices connected to Normal/Emergency power shall be red in color and pre-marked "Emergency" unless otherwise indicated on the Drawings or by the Architect.

2.6 ELECTRIC CORD REELS

- A. Hubbell Model HBLI45123GF220:
 - 1. UL 355/CSA 22.2 No. 308-14
 - 2. Two 20A duplex receptacles
 - 3. GFCI module with open neutral protection
 - 4. 45' of cable

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5. Reel with black impact resistant portable outlet box
 6. Durable corrosion resistant steel construction
 7. 12 AWG cord for a full 20A carrying capacity
 8. Provide all required mounting accessories
 9. Provide receptacle mounted on ceiling for cord reel
- B. Mounting Bracket:
1. Hubbell Model HBLIMB
- C. Color:
1. Industrial – Yellow
 2. Kitchen or Other – White
- D. Approved Equals:
1. Pass & Seymour Model CRCD123G50R20
 2. KH Industries Model RTAG3LW-WDD520-J12K
- E. Provide UL Type 4 for Cord Reels installed outdoors.
1. Hubbell Model HBLW45123

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Coordinate all device rough-in heights and locations with all other trades and finished room schedules as applicable. Report any conflicts to Architect/Engineer before rough-in.
- B. Verify conditions prior to beginning work.
- C. Verify that outlet boxes are installed at proper height.
- D. Verify that wall openings are neatly cut and will be completely covered by wall plates.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install in accordance with NECA "Standard of Installation" except for mounting heights. Refer to Section 260010 for mounting heights.
- B. Device terminals may not be used to carry the continuity of the branch circuit. All branch circuit wiring must be spliced and tailed out to devices.
- C. Install devices and assemblies' plumb and level.
- D. Install single pole switches with OFF position down.
- E. Install ganged wall dimmers as recommended by manufacturer to achieve full rating specified.
- F. Install dedicated neutral conductors on-line and load side of dimmers.

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- G. Install vertical receptacle installations with grounding pole opening up/on top.
- H. Install horizontal receptacle installations with the neutral pole opening side up/on top.
- I. Group adjacent switches and/or receptacles in single multi-gang wall plate. Provide internal box dividers as required by the NEC.
- J. Connect wiring device grounding terminal to metallic outlet box with a grounding wire conductor and the branch circuit equipment grounding conductor.
- K. Connect wiring devices by wrapping solid conductor around screw terminal. Connect solid and stranded wires by inserting in screw tension pressure plate connectors. Provide solid tails or solderless connectors for stranded conductors where screw tension pressure plates are not available. Use of spring tension back wired terminals is unacceptable.
- L. Coordinate with trade responsible for painting to ensure final coat has been applied before installing wall plates.
- M. Provide all devices, outlet boxes, junction boxes, etc. with the appropriate type cover plate.
- N. Use junior or jumbo size plates for all outlets installed in masonry walls.
- O. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on devices installed in surface mounted boxes.
- P. When plastic wall plates are used throughout on a commercial project, provide super stainless-steel type wall plates in exposed commercial kitchen areas.
- Q. Provide panel/circuit information at each wiring device as specified in the identification specifications.
- R. When isolated wiring devices are used, connect the wiring device grounding terminals to a dedicated isolated grounding conductor. A separate equipment grounding conductor shall also be installed and used for metallic raceway and outlet box grounding. Install per NEC requirements.
- S. Provide a ground fault receptacle at each location indicated on the Drawing. Use of the feed-through feature is not permitted.
- T. Provide a surge protected receptacle at each location indicated on the Drawing. Use of the feed-through feature is not permitted.
- U. Install electric cord reels in accordance with manufacturer's recommendations.

3.4 CONNECTIONS

- A. Ground equipment in accordance with Section 260526.
- B. Wire all devices in accordance with Section 260519.
- C. 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.

3.5 FIELD QUALITY CONTROL

- A. Provide field inspection, testing, adjusting, and balancing.
- B. Inspect each wiring device for defects.

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- C. Operate each wall switch with circuit energized and verify proper operation.
- D. Verify that each receptacle device is energized.
- E. Perform the following field tests and inspections:
 - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
 - 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- F. Remove malfunctioning units, replace with new units, and retest as specified above.
- G. Check each TVSS receptacle indicating lights for normal indication.

3.6 ADJUSTING

- A. Adjust installed work as required to meet field conditions.
- B. Adjust devices and wall plates so they are flush and level.

3.7 CLEANING

- A. Clean installed work as required.
- B. Clean exposed surfaces to remove splatters and restore finish.

3.8 SETUP

- A. Provide dip switch setting for the following setup:
 - 1. Single Button Automatic wall switch:
 - a. On – Manual
 - b. Off – Sensor (15-minute delay)
 - 2. Two button automatic wall switch:
 - a. On – Manual
 - b. Off – Sensor (15-minute delay)
 - 3. 0-10V dimming wall switch occupancy sensor:
 - a. On – Manual
 - b. Off – Sensor (15-minute delay)
 - 4. All automatic wall switches and occupancy sensors in Restrooms shall be set to Auto ON.

END OF SECTION 262726

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SECTION 262730 – FLOOR BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Multi-Service Floor Boxes

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NECA - Standard of Installation

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate dimensions, colors and configurations with the specific item and model numbers highlighted.
 - d. Spreadsheet with Room Name/Number and floor boxes/poke-thru's type to be installed for all floor boxes/poke-thru's type on the project.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Submit record copy of all testing performed.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3-years' experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Provide Products listed and classified by Underwriters Laboratories, as suitable for the purpose specified and indicated.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage and are identified with labels describing contents.
 - 1. Cover Plates: 1 for every 20 of each style, size and finish installed. Furnish at least 2 of each type, style, size, and finish installed.

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1.8 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 FLOOR BOXES – GENERAL

- A. Contractor to provide floor box where specific model numbers are listed on the Drawings.
- B. Contractor to provide floor box indicated or required.
- C. Provide all proper plates, brackets, and accessories to properly mate with specified wiring devices, floor thickness and floor finish (i.e. carpet or tile).
- D. All floor boxes installed on any floor type other than carpet must meet or exceed UL requirements for Scrub Water Exclusion.
- E. Devices installed in floor boxes must meet or exceed devices listed in other 260000 sections.

2.2 MULTI-SERVICE FLOOR BOXES

- A. Floor Box Convenience Receptacle(s) and Telecommunication Outlet(s) Concrete Floor:
 - 1. Housing: Cast iron or epoxy coated for on-grade, stamped steel for above grade.
 - 2. Plate Finish: Nickel (Verify with Architect)
 - 3. Configuration: Receptacles and Telecommunication outlets as indicated on the Drawings.
 - 4. Box and cover shall meet UL 514A Water Exclusion Test
 - 5. Manufacturers:
 - a. Wiremold Model RFBA10C55OG, RFBA6C30OG, RFBA4C30OG, OR RFBA2C30OG (epoxy coated); RFBA10C55, RFBA6C30, RFBA4C30 or RFBA2C30 (stamped steel) with (1) XCTC2NK cover, duplex mounting plates, data mounting plates and all required components for a complete installation.
 - b. Hubbell Model CFB10G55RCRE, CFB6G30RCRE, CFB4G30RCRE, or CFB2G30RCRE (epoxy coated); CFB10G55RE, CFB6G30RE, CFB4G30RE, or CFB2G30RE (stamped steel) with (1) CFBS1RXCVRNKL cover, duplex mounting plates, data mounting plates and all required components for a complete installation.
 - c. Provide all necessary power and telecommunication fittings required for a complete installation.
 - d. Provide conduits as required for components shown and a spare 1-1/4" conduit to accessible ceiling cavity for future use.
- B. Floor Box Convenience Receptacle(s) and Telecommunication Outlet(s) and Telecommunication Outlet(s), Wood Floor:
 - 1. Housing: Stamped steel
 - 2. Plate Finish: Aluminum (Verify with Architect)
 - 3. Configuration: Two duplex receptacles and telecommunication outlets unless otherwise indicated.
 - 4. Box and cover shall meet UL 514A Water Exclusion Test
 - 5. Manufacturers:
 - a. Wiremold Model 880WX with Activation Kit as applicable.
 - b. Hubbell Model B2481 with cover as required.
 - c. Provide all necessary power and telecommunication fittings required for a complete installation.
 - d. Provide conduits as required for components shown.

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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions prior to beginning work.
- B. Verify that floor boxes are adjusted properly.
- C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- D. Verify that openings in access floor are in proper locations.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install devices plumb and level.
- B. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
- C. Coordinate location of all floorboxes with furniture provided by General Contractor or Owner before roughing-in (verify)
- D. Install all wiring between floor box to pre-wired furniture in liquid tight conduit.

3.4 FIELD QUALITY CONTROL

- A. Provide field inspection, testing, adjusting, and balancing.

3.5 ADJUSTING

- A. Adjust locations of floor boxes to suit the arrangement of furniture and as recommended by Architect.

3.6 CLEANING

- A. Clean installed work as required.

END OF SECTION 262730

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SECTION 262740 – OUTDOOR GROUND BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Outdoor Ground Boxes

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NECA - Standard of Installation

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate dimensions, colors and configurations with the specific item and model numbers highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Submit record copy of all testing performed.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3-years' experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Provide Products listed and classified by Underwriters Laboratories, as suitable for the purpose specified and indicated.

1.7 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design: Legrand/Wiremold

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2.2 OUTDOOR GROUND BOXES

- A. Classification and Use: Outdoor ground boxes shall have been examined and tested by Underwriters Laboratories Inc. to meet NEMA 6P and IP68 requirements to be safe to use even during inclement weather and bear the UL Listing Mark.
- B. Outdoor Ground Boxes, General:
 - 1. Outdoor ground boxes shall be designed to trap and maintain an air pocket to protect the devices, plugs and connections from water, snow, and ice. Boxes shall be constructed from UV rated chemical resistant materials. Boxes designed to ANSI/SCTE 77 with a Tier 5 rating to hold up to 5000 lbs of load. Boxes install flush to finished ground reducing tripping hazards. Box shall have a diving bell concept to maintain an air pocket and keep water away from connections. Box shall have an egress door that will auto-adjust to cable diameter and auto-lock in the closed position when no cables are exiting the box.
- C. Model XB814 Exterior Ground Boxes: Single service 2-gang ground box manufactured from UV rated nonmetallic material. Box accepts up to two 1-1/4" trade size PVC conduit feeds. Boxes designed to be installed separately or ganged together for greater capacity and flexibility. Accepts optional XB814 cover assembly. Boxes shall be 16-1/8" L x 8-1/8" W x 10-3/4" H. Box assemblies include main box body, installation cap, and installation plate.
 - 1. Architect to select finish. (Brown, Black or Gray)
- D. Model XB814C520XX Exterior Box Cover Assembly 5-20R: Assembly prewired with two (2) 20A L5-20R weather-resistant duplex receptacles. Box assemblies shall be 16-1/8" L x 8-1/16" W x 10-3/4" H. Cover assembly includes flange, cover, junction box, (2) 20A 5-20R receptacles, SOOW cord, wet location wire connectors, key, and mounting hardware.
 - 1. Provide 1P.20A ground fault breaker to feed receptacles.
- E. Model XB814CLVXX Exterior Box Cover Assembly Low Voltage: Assembly designed to accept up to 12 communication ports or eight (8) Legrand AVIP devices. Cover assemblies shall be 16-1/8" L x 8-1/16" W x 10-3/4" H. Cover assembly includes flange, cover, junction box, corrugated conduit assembly, (1) 12 port communication mounting plate, (1) 8 port Legrand AVIP audio/video mounting plate, key, and mounting hardware.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions under which outdoor ground boxes are to be installed. Notify the Architect/Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 INSTALLATION

- A. Strictly comply with manufacturer's installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
- B. Install devices plumb and level.
- C. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

3.3 FIELD QUALITY CONTROL

- A. Provide field inspection, testing, adjusting, and balancing.

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3.4 CLEANING AND PROTECTION

- A. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
- B. Protect boxes until acceptance.

END OF SECTION 262740

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SECTION 262813 – FUSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fuses
- B. Spare Fuse Cabinet

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electric Code
- B. NEMA FU 1 - Low Voltage Cartridge Fuses

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate electrical characteristics, time curves, fuse coordination on a 11"x17" time curve graph paper with specific item or model number highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual fuse sizes.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by UL or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Fuses: Furnish 3 of each size and type installed.

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1.8 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Cooper Bussman
- B. Littlefuse, Inc.
- C. Mersen

2.2 FUSE REQUIREMENTS

- A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
- B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
- C. All fuses in the power distribution system shall be by the same manufacturer.
- D. Main Service Switches Larger than 600 amperes: Current Limiting Class L (time delay).
- E. Motor Load Feeder Switches: Current Limiting Class RK1 (time delay).
- F. Motor Branch Circuits: Class RK5. (time delay).
- G. Parallel service and feeder cables - cable limiters.

2.3 SPARE FUSE CABINET

- A. Description: Wall-mounted sheet metal cabinet, suitably sized to store spare fuses and fuse pullers specified.
- B. Doors: Hinged, with hasp for Owner's padlock.
- C. Finish: Primed and painted medium gray.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in accordance with manufacturer's instructions.
- B. Install fuse with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet where directed by Owner.
- D. Provide an adhesive label inside each enclosure or compartment indicating the size and type of replacement fuse to be installed. Where multiple sizes or types of fuses are installed in a single enclosure placement or coding of labels shall clearly indicate the fuses to which the labels refer.
- E. Install cable limiters on both ends of each parallel cable in the designated set.

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END OF SECTION 262813

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SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fusible Switches
- B. Non-Fusible Switches
- C. Enclosed Circuit Breakers

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NECA - Standard of Installation (Published by the National Electrical Contractors Association)
- C. NEMA FU1 - Low Voltage Cartridge Fuses
- D. NEMA KS 1 - Enclosed Switches
- E. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (published by the International Electrical Testing Association).
- F. NEMA AB 1 Molded Case Circuit Breakers

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate type, switch ratings, dimensions and enclosure with the specific items or model numbers highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Maintenance Data: Include spare parts data, recommended maintenance procedures and intervals.
- C. Submit record copy of all testing performed.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Installation Instructions: Install in accordance with application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Store, handle, protect, examine, prepare, install, and start the product in accordance with the manufacturer's instructions.

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1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by UL or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage and are identified with labels describing contents.
 - 1. Fuses: Provide 3 of each size and type of fuse installed.

1.9 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Square D Company
- B. Eaton
- C. Siemens

2.2 ENCLOSED SWITCHES

- A. Fusible Switch Assemblies: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Designed to accommodate specified fuses.
- B. Non-fusible Switch Assemblies: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

2.3 MOLDED CASE CIRCUIT BREAKERS

- A. Circuit Breaker: NEMA AB 1.
- B. Service Conditions:
 - 1. Temperature: 104°F
 - 2. Altitude: 6000'
- C. Interrupting Rating: As indicated on the drawings.

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2.4 MOLDED CASE CIRCUIT BREAKERS - TRIP UNITS

- A. Permanent (fixed) Trip Circuit Breaker: Provide circuit breakers with frame sizes 100 Amps and larger with permanent thermal and magnetic trip units in each pole.
- B. Provide type HCAR circuit breakers for air conditioning and refrigeration branch circuits.

2.5 MOLDED CASE CIRCUIT BREAKERS - OPTIONS AND FEATURES

- A. Provide accessories as scheduled, to NEMA AB 1.
- B. Handle Lock: Include provisions for padlocking.
- C. Load Side Terminations: Provide lugs on circuit breakers of sufficient size to terminate conductors scheduled or indicated on plans.
- D. Provide grounding lug in each enclosure.
- E. Provide Products suitable for use as service entrance equipment where so applied.
- F. Minimum Integrated Short Circuit Rating: Adjusted per Fault-Current Study:
 - 1. Amperes Interrupting Current (AIC) Ratings: 120V, 208V, and 240V breaker – minimum AIC 10,000 amps unless otherwise noted on the Drawings or Specifications.
 - 2. Amperes Interrupting Current (AIC) Ratings: 277V and 480V breaker – minimum AIC 18,000 amps unless otherwise noted on the Drawings or Specifications.
 - 3. The Contractor shall verify the AIC with the fault current study and adjust as required to comply with the study.

2.6 ENCLOSURE

- A. Enclosures: NEMA KS 1.
 - 1. Interior Dry Locations: Type 1
 - 2. Interior Wet Locations: Type 4
 - 3. Exterior Locations: Type 3R
 - 4. Kitchen: Stainless Steel
 - 5. Dishwashing Rooms/Areas: Stainless Steel

2.7 FUSES

- A. Refer to Section 262813.

2.8 LOAD SIDE TERMINATIONS

- A. Provide lugs on switches of sufficient size to terminate conductors scheduled or indicated on plans.

2.9 IDENTIFICATION

- A. Enclosed Switches and Circuit Breakers Engraved Plastic Nameplates: Engraving stock, melamine plastic laminate, minimum 1/16" thick for nameplates up to 20 sq. in. and 1/8" thick for larger sizes.
 - 1. Engraved legend shall be black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
- B. Fasteners for Nameplates: Self-tapping, stainless-steel screws, or #10/32 stainless-steel machine screws with nuts and flat and lock washers.

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PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches where indicated and in accordance with NECA "Standard of Installation".
- B. Install fuses in fusible disconnect switches.
- C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.
- D. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.
- E. Install enclosed circuit breakers plumb. Provide supports in accordance with Section 260529.
- F. Refer to Section 260010 for mounting heights.
- G. Provide engraved plastic nameplates for each enclosed switch and circuit breaker with 1/2" high lettering. Label shall include the following:
 - 1. Enclosed Switch or Circuit Breaker Name
 - 2. Voltage
 - 3. Size

3.2 FIELD QUALITY CONTROL

- A. Field inspection, testing, adjusting as required.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.
- D. Test and inspect each circuit breaker.
- E. Inspect and test each circuit breaker to NEMA AB 1.
- F. Inspect each circuit breaker visually.
- G. Perform several mechanical ON OFF operations on each circuit breaker.
- H. For record - verify circuit continuity on each pole in closed position.

3.3 ADJUSTING

- A. Adjust work as required.

END OF SECTION 262816

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SECTION 262913 – ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manual Motor Starters
- B. Magnetic Motor Starters
- C. Combination Magnetic Motor Starters

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Type
- C. UL 198E - Class R Fuses
- D. NECA "Standard of Installation," published by National Electrical Contractors Association
- E. NEMA AB 1 - Molded Case Circuit Breakers
- F. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies
- G. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- H. NEMA KS 1 - Enclosed Switches

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate voltage, controller size, rating, size of switching, overcurrent protective device, short circuit ratings, dimensions and enclosure with the specific item or model number highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under the provisions of Section 260010.
- B. Maintenance Data: Include spare parts data and recommended maintenance procedures and intervals.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with NECA Standard of Installation except for mounting heights.
- B. Maintain one copy of each document on site.

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1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc., or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Fuses: Furnish 3 of each size and type installed.

1.9 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Square D Company
- B. Eaton
- C. Siemens
- D. Allen Bradley

2.2 MANUAL CONTROLLERS

- A. Manual Motor Controller: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller with overload element, red pilot light, and toggle operator.
- B. Fractional Horsepower Manual Controller: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light and toggle operator.
- C. Motor Starting Switch: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with red pilot light and toggle operator.

2.3 AUTOMATIC CONTROLLERS

- A. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- B. Reversing Controllers: Include electrical interlock and integral time delay transition between FORWARD and REVERSE rotation.

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- C. Two Speed Controllers: Include integral time delay transition between FAST and SLOW speeds.
- D. Coil operating voltage: 120 volts, 60 Hertz.
- E. Overload Relay: NEMA ICS; melting alloy.

2.4 PRODUCT OPTIONS AND FEATURES

- A. Auxiliary Contacts: NEMA ICS 2, one each normally open and closed field convertible contacts in addition to seal-in contact.
- B. Cover Mounted Pilot Devices: NEMA ICS 2, heavy duty oil-tight type 30.5mm round.
- C. Pilot Device Contacts: NEMA ICS 2, Form Z, rated A150.
- D. Pushbuttons: Recessed type.
- E. Indicating Lights: Transformer type.
- F. Selector Switches: Rotary type.
- G. Control Power Transformers: 120-volt secondary, NEMA IS2 recommended volt amperes minimum, in each motor starter. Provide fused primary and secondary, and bond unfused leg of secondary to enclosure.
- H. Load Side Terminations: Provide lugs on circuit breakers of sufficient size to terminate conductors scheduled or indicated on plans.
- I. Single Phasing Protection: (Three Phase Units)

2.5 COMBINATION UNITS

- A. Combination Controllers: Combine motor controllers with thermal magnetic circuit breaker or fusible switch disconnect in common enclosure.
- B. Thermal Magnetic Circuit Breakers: NEMA AB 1, with integral thermal and instantaneous magnetic trip in each pole.

2.6 ENCLOSURE

- A. Enclosure: NEMA ICS 6
 - 1. Interior Dry Locations: Type 1
 - 2. Interior Wet Locations: Type 4
 - 3. Exterior Locations: Type 3R
 - 4. Kitchen: Stainless Steel
 - 5. Dishwashing Rooms/Areas: Stainless Steel

2.7 IDENTIFICATION

- A. Enclosed Controllers Engraved Plastic Nameplates: Engraving stock, melamine plastic laminate, minimum 1/16" thick for nameplates up to 20 sq. in. and 1/8" thick for larger sizes.
- B. Fasteners for Nameplates: Self-tapping, stainless-steel screws, or #10/32 stainless-steel machine screws with nuts and flat and lock washers.

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PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.
- B. Install enclosed controllers' plumb. Provide supports in accordance with Section 260529.
- C. Refer to Section 260010 for mounting heights.
- D. Install fuses in fusible switches.
- E. Provide engraved plastic nameplates for each contactor with 1/2" high lettering. Label shall include the following:
 - 1. Controller Name
 - 2. Circuit

3.2 FIELD QUALITY CONTROL

- A. Perform inspection and testing.
- B. Inspect and test each enclosed controller to NEMA ICS 2.

END OF SECTION 262913

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SECTION 263213 – ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
 - 1. Fuel: Diesel
 - 2. Location: Outdoor

1.2 RELATED WORK/DIVISIONS

- A. Division 23

1.3 REFERENCES

- A. NEMA AB1 - Molded Case Circuit Breakers
- B. NEMA MG1 - Motors and Generators
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- D. NFPA 30 - Flammable and Combustible Liquids Code
- E. NFPA 70 - National Electrical Code
- F. NFPA 101 - Life Safety Code
- G. NFPA 110 - Emergency and Standby Power Systems

1.4 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate size, voltage, rating, current rating, dimensions, exhaust silencer, battery charger, transfer switch enclosure and etc with the specific item or model number highlighted.
 - d. Sketch of exhaust piping and copy of exhaust back pressure calculations.
 - e. Fuel consumption rate curves at various loads.
 - f. Ventilation and combustion air requirements.
 - g. Manufacturers certificate that product meets or exceeds specified requirements and test report indicating results of performance testing.
- C. Generator Sizing Report:
 - 1. Create generator sizing report using computer software developed by the generator manufacturer.
 - 2. Include loads as indicated.

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3. Sizing parameters:
 - a. Maximum Peak Voltage Dip: 30% (15% if fire pump is connected to generator)
 - b. Maximum Peak Frequency Dip: 10%
 - c. Standby Duty

1.5 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Manufacturer's Field Report
- C. Indicate procedures and findings.
- D. Operation Data: Include instructions for normal operation.
- E. Maintenance Data: Include instructions for routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 110.
- B. Maintain one copy of document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.
- B. Supplier: Authorized or franchised distributor with service facilities for generator, transfer switches and other accessories and must have a minimum of three years documented experience.

1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70 and NFPA 101.
- B. Furnish Products listed and classified by Underwriters Laboratories testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site.
- B. Accept unit on site on skids. Inspect for damage.
- C. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

1.10 MAINTENANCE SERVICE

- A. Furnish service and maintenance of engine generator for one year (minimum 2 visits from Date of Substantial Completion).

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1.11 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Fuel Filter: 2 of each type installed.
 - 2. Oil Filter: 2 of each type installed.
 - 3. Air Filter: 2 of each type installed.
 - 4. Trap Breather Filter: 2 of each type installed.

1.12 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Cummins Power Generation
- B. Alternate manufacturers as listed below:
 - 1. Kohler Power Systems
 - 2. Caterpillar Tractor Company
 - 3. MTU Onsite Energy
- C. Alternate manufacturers subject to compliance with the following requirements:
 - 1. The dimensions of the alternate manufacturer will fit in the proposed location and that all required clearances per NEC Access and Maintenance are maintained.
 - 2. The performance and operating characteristics meet or exceed the Basis of Design.
 - 3. The alternate manufacturer shall include all features, accessories and additional equipment required for a complete installation.
 - 4. The alternate manufacturer shall submit a generator sizing report with all loads and number of steps. If the basis of design size indicated is not adequate to start and run the loads, the manufacturer shall increase the size as required to meet the performance of the basis of design. The contractor shall provide the increased generator size, and all required electrical/mechanical/plumbing modifications.
 - 5. The contractor is responsible for any cost associated with providing the options required to meet the specification.

2.2 PACKAGE ENGINE GENERATOR SYSTEM

- A. Description: NFPA 110, engine generator system to provide source of power for Level 1 – Type 10 applications and conforming to NFPA 99.
- B. System Capacity: As indicated at elevation of 1500' above sea level, standby rating using engine-mounted radiator.
- C. Compliance: Must comply with UL2200 and be in accordance with IBC 2009 requirements.
- D. The generator manufacturer shall comply with current EPA Regulations.

2.3 ENGINE

- A. Type: Water-cooled inline or V-type, four stroke cycle electric ignition internal combustion engine. Maximum engine RPM shall not exceed alternator speed.

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- B. Rating: 100% of nameplate rating for duration of any power outage with no derate.
- C. Fuel System: Diesel Fuel
- D. Engine Speed: 1800 RPM maximum
- E. Governor: Isochronous or electronic type to maintain engine speed within 0.5% steady state, and 5% no load to full load, with recovery to steady state within 2 seconds following sudden load changes.
- F. Safety Devices: Engine shutdown on low coolant level, high coolant temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.
- G. Engine Starting: DC starting system with positive engagement, number, and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.
- H. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90°F. Manufacturer to confirm coolant heater wattage and voltage.
- I. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110°F. Radiator airflow restriction 0.5" of water (1.25 Pa) maximum.
- J. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gauge, water temperature gauge, and lube oil pressure gauge on engine/generator control panel.
- K. Mounting: Provide unit with suitable spring-type vibration isolators and mount on structural steel base if integral pad type isolation is not provided.

2.4 GENERATOR

- A. Generator: NEMA MG1, 3-phase, 4-pole, reconnectible brushless synchronous generator with brushless exciter.
- B. Rating: As indicated on drawings, at 0.8 power factor, 60 Hz at 1800 rpm.
- C. Insulation Class: H
- D. Temperature Rise: 105°C Stand-by
- E. Enclosure: NEMA MG1, open drip proof
- F. Voltage Regulation: Include generator-mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation $\pm 1\%$ from no load to full load. Include manual controls to adjust voltage droop, voltage level ($\pm 5\%$) and voltage gain.
- G. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or 3-phase fault at approximately 300% of rated current for not more than 10 seconds.

2.5 GENERATOR BREAKERS

- A. Legally Required Loads Breaker

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1. Square D – Mission Critical Modeled Case Circuit Breaker:
 - a. NEMA AB 1.
 - b. High levels of selective coordination in an electronic trip circuit breaker.
 - c. Time/Current response adjustments: Long Time Pick-Up, Long Time Delay, Short Time Pick-Up, Short Time Delay, and Instantaneous settings.
 - d. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - e. Mount unit in enclosure to meet NEMA 250, Type 1 requirements.
 - B. Optional Standby Systems Loads Breaker:
 1. Electronic Trip Circuit Breaker
 - a. NEMA AB 1.
 - b. Time/Current response adjustments: Long Time Pick-Up, Long Time Delay, Short Time Pick-up, Short Time Delay, and Instantaneous settings.
 - c. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - d. Mount unit in enclosure to meet NEMA 250, Type 1 requirements.
 - C. Critical Loads Breaker:
 1. Square D – Mission Critical Modeled Case Circuit Breaker:
 - a. NEMA AB 1.
 - b. High levels of selective coordination in an electronic trip circuit breaker.
 - c. Time/Current response adjustments: Long Time Pick-Up, Long Time Delay, Short Time Pick-up, Short Time Delay, and Instantaneous settings.
 - d. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - e. Mount unit in enclosure to meet NEMA 250, Type 1 requirements.
 - D. Fire Pump Breaker:
 1. Electronic Trip Circuit Breaker
 - a. NEMA AB 1.
 - b. Time/Current response adjustments: Long Time Pick-Up, Long Time Delay, Short Time Pick-up, Short Time Delay, and Instantaneous settings.
 - c. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - d. Mount unit in enclosure to meet NEMA 250, Type 1 requirements.
 - E. Provide circuit breakers in the quantity and size of the transfer switches unless otherwise noted.
 - F. Provide a permanently fastened pad lockable hasp accessory for each breaker.
 - G. Provide a simple coordination study to set up breakers if Section 260573 is not included. If Section 260573 is included, breakers shall be set-up as part of the study.
- 2.6 ACCESSORIES
- A. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless-steel exhaust fitting, sized in accordance with engine manufacturer's instructions. Electrical Contractor shall provide pipe extension and drip-cup and provide proper type thimble for exhaust pipe protruding thru wall or roof.
 - B. Batteries: Heavy duty, diesel starting type lead-acid storage batteries, 170-ampere hours minimum capacity as recommended by the engine manufacturer. Match battery voltage to starting system. Include necessary cables and clamps.

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- C. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.
- D. Battery Tray Heater: Provide heater for all exterior generators.
- E. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet NEMA 250, Type 1 requirements.
- F. Remote Emergency Stop Kit for indoor or outdoor generator.
- G. Provide manufacturers standard rodent guards for outdoor generator.

2.7 SKID MOUNTED FUEL TANK

- A. Provide a UL142 compliant, integral, double wall, spill containment, steel tank with usable capacity for 24 hour run at 100% load.
 - 1. Provide secondary containment with leak detection alarm panel.
 - 2. Provide direct reading fuel gauge.
 - 3. Provide five gallon spill fill box.
 - 4. Provide audio/visual fuel level alarm panel.
- B. If the height of the skid mounted fuel tank raises the circuit breakers and control panels above 6'-0", provide an OSHA compliant working platform to access equipment.
 - 1. Provide the OSHA compliant working platform to access all generator equipment with the following items as required for the installation.
 - a. Permanent structure with concrete pad as required.
 - b. Constructed of prefabricated industrial grade aluminum.
 - c. Access stairs.
 - d. Guardrails and handrails.
 - e. Platform to be sized to meet the working clearances of the NEC.
- C. Provide low fuel and rupture basin alarms for tank.
- D. Provide Donaldson TRAP breather filter and replace manufacturers standard mushroom cap on normal vent.
 - 1. This will filter vent air and help strip moisture to prevent condensation from building up within the tank.
- E. Provide Morrison Bros. Co 178 series sealable, lockable cap and replace manufacturers standard existing turtle cap.
 - 1. A sealable cap will help prevent water entry and help direct all vent air to the standard normal vent pipe.
- F. Provide Morrison Bros. Co 244 series UL listed emergency vent in addition to the normal vent.
 - 1. Vent to be installed to help prevent the tank from becoming over-pressurized and possibly rupturing if ever exposed to fire.

2.8 OUTDOOR WEATHER PROTECTIVE ENCLOSURE

- A. The generator set shall be provided with an outdoor enclosure, with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure and sub-base fuel tank (when used) shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100°F. The housing shall have hinged

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access doors as required to maintain easy access for all operating and service functions. All doors shall be lockable and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.

- B. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer's standard color using a dual coat cathodic electro-deposition process or equal meeting the performance requirements specified below. This process utilizes an 11-stage cleaning and pre-treatment, with a bake-cured epoxy primer for corrosion resistance, and a bake-cured acrylic topcoat for durability and UV resistance. This process provides consistency in coating thickness over all coated parts, and a finish devoid of runs, sags, or pin holes. This is important in maintaining a quality appearance in the product and because corrosion will begin in areas which are incompletely coated. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:
- Primer thickness: 0.6-1.2 mils. Topcoat thickness, 0.8-1.5 mils
 - Gloss, per ASTM D523-89, 80% $\pm$ 5%. Gloss retention after 1 year shall exceed 50%.
 - Crosshatch adhesion, per ASTM D3359-93, 4B-5B
 - Impact resistance, per ASTM D2794-93, 120-160 inch-pounds
 - Salt spray, per ASTM B117-90, 1000+ hours
 - Humidity, per ASTM D2247-92, 1000+ hours
 - Water soak, per ASTM D2247-92, 1000+ hours
1. Painting of hoses, clamps, wiring harnesses and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant and designed to minimize marring of the painted surface when removed for normal installation or service work.
 2. Enclosure shall be constructed of minimum 12-ga steel for framework and 14-ga steel for panels. All hardware and hinges shall be stainless steel.
 3. A factory mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a raincap. Exhaust connections to the generator set shall be through seamless flexible connections.
 4. The enclosure shall include the following maintenance provisions:
 - a. Flexible coolant and lubricating oil drain lines that extend to the exterior of the enclosure, with internal drain valves.
 - b. External radiator fill provision.
 5. The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in an ambient temperature of up to 100°F. The enclosure shall reduce the sound level of the generator set while operating at full rated load and be designed for quiet site-second stage (maximum 75 dba at 7m).
 6. The enclosure shall be insulated with non-hydroscopic materials.

2.9 GENERATOR SET CONTROL PANEL

- A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- B. The control shall be mounted on the generator set or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- C. The generator set mounted control shall include the following features and functions:
1. Mode Select Switch: The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position the generator set shall start and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF Position the generator set shall immediately stop, bypassing all time delays. In the AUTO Position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.

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2. Emergency Stop Switch. Switch shall be red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator to immediately shut down and be locked out from automatic restarting.
 3. Reset Switch. The Reset Switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
 4. Panel Lamp Switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
- D. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:
1. Digital metering set, 1% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages and shall display all 3-phase voltages (line to neutral or line-to-line) simultaneously.
 2. Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending. Metering accuracy shall be within 1% at rated output. Analog metering is optional.
 3. The control system shall monitor the total load on the generator set and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.
 4. The control system shall log total number of operating hours, total KWH, and total control on hours, as well as total values since reset.
- E. Generator Set Alarm and Status Display:
1. The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:
 - a. The control shall include 5 configurable alarm-indicating lamps. The lamps shall be field adjustable for any status, warning, or shutdown function monitored by the genset. They shall also be configurable for color, and control action (status, warning, or shutdown).
 - b. The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.
 - c. The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.
 - d. The control shall include an amber common warning indication lamp.
 2. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:
 - low oil pressure (warning)
 - low oil pressure (shutdown)
 - oil pressure sender failure (warning)
 - low coolant temperature (warning)
 - high coolant temperature (warning)
 - high coolant temperature (shutdown)
 - high oil temperature (warning)
 - engine temperature sender failure (warning)
 - low coolant level (warning)
 - fail to crank (shutdown)
 - fail to start/overcrank (shutdown)
 - overspeed (shutdown)
 - low DC voltage (warning)
 - high DC voltage (warning)
 - weak battery (warning)

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low fuel day-tank (warning)
high AC voltage (shutdown)
low AC voltage (shutdown)
under frequency (shutdown)
over current (warning)
over current (shutdown)
short circuit (shutdown)
ground fault (warning) (optional-when required by code or specified)
overload (warning)
emergency stop (shutdown)
(4) configurable conditions

F. Engine Status Monitoring:

1. The following information shall be available from a digital status panel on the generator set control:
 - engine oil pressure (psi or kPA)
 - engine coolant temperature (°F or C)
 - engine oil temperature (°F or C)
 - engine speed (rpm)
 - number of hours of operation (hours)
 - number of start attempts
 - battery voltage (DC volts)
2. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

G. Engine control Functions:

1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
2. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
4. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
5. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure condition.

H. Alternator Control Functions:

1. The generator set shall include a full wave rectified automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from miss-operation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with 3-phase line to neutral RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.
2. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current

shutdown). The protective functions provided shall be in compliance to the requirements of NFPA 70 Article 445.

3. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA 70 Article 445.
4. Controls shall be provided to monitor the KW load on the generator set and initiate an alarm condition (overload) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
5. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.
6. When required by national Electrical Code or indicated on project drawings, the Control System shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8-1200 amps and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set and provide relay that will function correctly in system as installed.
7. The generator set control shall include a 120VAC-control heater.

I. Other Control Functions:

1. The generator set shall be provided with a network communication module to allow MODBUS compliant communication with the generator set control by remote devices. The control shall communicate all engine and alternator data and allow starting and stopping of the generator set via the network in both test and emergency modes.
2. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25 VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and DC voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

J. Control Interfaces for Remote Monitoring:

1. The control system shall provide four programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. The relays shall be configured to indicate:
 - a. generator set operating at rated voltage and frequency
 - b. common warning
 - c. common shutdown
 - d. load shed command
2. A fused 10-amp switched 24 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
3. A fused 10-amp 24 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
4. The control shall be provided with a direct serial communication link for the MODBUS communication network interface as described elsewhere in this specification and shown on the drawings.

2.10 REMOTE ANNUNCIATOR PANEL

A. Provide a 16-light minimum LED type remote alarm annunciator with horn.

1. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for Level 1 systems for the local generator control panel.
2. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator.
3. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided.

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4. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable and indicating lamp color shall be capable of changes needed for specific application requirements.
5. Alarm horn shall be switchable for all annunciation ports.
6. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA 110 3.5.6.2.
7. The interconnecting wiring between the annunciator and other system components shall be monitored and failure of the interconnection between components shall be displayed on the annunciator panel.

B. The annunciator shall include the following alarm labels, audible annunciation features, and lamp colors:

Condition	Lamp Color	Audible Alarm
Normal Power (to Loads)	Green	No
Genset Supplying Load	Amber	No
Genset Running	Green	No
Not in Auto	Red (Flashing)	Yes
High Battery Voltage	Red	Yes
Low Battery Voltage	Red	Yes
Charger AC Failure	Red	Yes
Fail to Start	Red	Yes
Low Temperature	Amber	Yes
PreHigh Engine Temperature	Amber	Yes
High Engine Temperature	Red	Yes
Pre-Low Oil Pressure	Amber	Yes
Low Oil Pressure	Red	Yes
Overspeed	Red	Yes
Low Coolant Level	Amber	Yes
Low Fuel Level	Amber	Yes
Network OK	Green	Yes
(4) Spares	Configurable	Configurable

C. Low battery voltage lamp shall also be lighted for low cranking voltage or weak battery alarm.

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PART 3 - EXECUTION

3.1 OUTDOOR PREPARATION

- A. Provide pad for each generator as detailed on the drawings.

3.2 DIESEL GENERATOR SCOPE OF WORK

- A. The Electrical Contractor shall properly seal and caulk all new pipes and fittings to prevent water entry.
- B. The Electrical Contractor shall provide diesel fuel to fill tank.
- C. The Electrical Contractor shall connect the spill alarm panel to a spare light on the remote annunciator. Label light to indicate spill alarm panel.
- D. The Electrical Contractor shall connect the low fuel and rupture basin alarms to spare lights on the remote annunciator. Label lights to indicate low fuel and rupture basin alarms.
- E. The Electrical Contractor shall provide a concrete pad with frost walls and piers as required to support the generator working platform.
- F. When the fuel maintenance system is included:
 - 1. The Electrical Contractor shall connect the 24V DC, N.O. leak detector on the fuel maintenance system to the leak detection alarm panel. Provide wiring/conduit as required.
 - 2. The Electrical Contractor shall provide (2) 1P.20A circuit breakers in closest normal/emergency panel and connect to the fuel maintenance system & the fuel maintenance system heater with 4#10 + 1#10 gnd in 1" conduit unless otherwise noted.
 - 3. The Electrical Contractor shall provide a spare 1" conduit between the fuel maintenance system and the building for the Modbus wiring.
 - 4. The Plumbing Contractor shall provide fuel piping between the tank and the fuel maintenance system as required by the manufacturer.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide flexible conduit and hoses in all electrical, fuel, cooling, exhaust, and lubrication lines which connect to the engine generator set. Install flexible lines to avoid interference with the operation of vibration isolators.
- C. Install conduits and piping to enter enclosures through the floor or as indicated. Do not penetrate removable or hinged panels or structural members above the skid base.
- D. Provide all fuel piping and connections required.
- E. Provide flexible conduit at connections to generator.
- F. Provide open space where conduits connect to generator.
- G. Install remote annunciator at location shown on the drawings. When not shown on the drawings, install in a location readily observed/monitored by facility personnel. Provide 1" conduit between generator and remote annunciator with wiring required.
- H. Install emergency stop at location shown on the drawings or at location coordinated with Engineer.

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- I. Provide connection point for ATC System to monitor if the generator is on or off.
- J. Provide a 1P.20A circuit breaker in closest panel and connect to battery charger and additional generator equipment with 2#10 + 1#10 gnd in 3/4" conduit unless otherwise noted.
- K. Provide a 1P.30A circuit breaker in closest panel and connect to block heater with 2#10 + 1#10 gnd in 3/4" conduit unless otherwise noted. Provide breaker and wire sizes recommended by manufacturer.
- L. Install a sign at the main switchgear noting the location of the emergency generator: ie: "NOTE: EMERGENCY GENERATOR LOCATED OUTSIDE OF BUILDING".
- M. For non-separately derived generators (solid neutral) provide an additional sign at the service entrance equipment with the following warning in accordance with NEC 700.7.B: "WARNING SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING UMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCE(S) IS ENERGIZED"

3.4 FIELD QUALITY CONTROL

- A. Provide the services of the Manufacturer's authorized technician to perform field inspection and testing. Verify correct fluid types and levels, correct fuel supply and pressure, and required connections. Submit report to Engineer.
- B. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal. Use the connected load for all tests.
- C. Provide full load test utilizing portable test bank for 2 hours or as required by authorities having jurisdiction. Record in 20-minute intervals during 2-hour test:
 - 1. Kilowatts
 - 2. Amperes
 - 3. Voltage
 - 4. Coolant temperature
 - 5. Room temperature
 - 6. Frequency
 - 7. Oil pressure
- D. Test alarm and shutdown circuits by simulating conditions.

3.5 ADJUSTING

- A. Adjust work as required.
- B. Adjust generator output voltage and engine speed, under expected load condition.

3.6 CLEANING

- A. Clean work as required.
- B. Clean engine and generator surfaces.

3.7 DEMONSTRATION

- A. Provide systems demonstration as required. Instruct at least two Owner's representatives for 1-hour minimum.

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- B. Describe loads connected to emergency and standby system and restrictions for future load additions.
- C. Simulate power outage by interrupting normal source and demonstrate that system operates to provide emergency and standby power.

END OF SECTION 263213

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SECTION 263600 – TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Automatic Transfer Switch

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code
- B. NEMA ICS 1 - General Standards for Industrial Control and Systems
- C. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies
- D. NEMA ICS 6 - Enclosures for Industrial Controls and Systems

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate size, voltage and current rating, operating logic, short circuit rating and enclosure details with specific item or model number highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Operation Data: Include instructions for operating equipment. Include instructions for operating equipment under emergency conditions when engine generator is running.
- C. Maintenance Data: Include routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.
- B. Supplier: Authorized or franchised distributor of specified manufacturer with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by UL or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

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1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 260010.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure, and finish.

1.8 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings or instructed by manufacturer.

1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of transfer switch for one year (minimum 2 visits) from Date of Substantial Completion.

1.10 MAINTENANCE MATERIALS

- A. Provide 2 keys per switch for maintenance.

1.11 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Onan Corporation
- B. Kohler Power Systems
- C. Automatic Switch Co. (ASCO)

2.2 AUTOMATIC TRANSFER SWITCH

- A. Description: NEMA ICS 2, automatic transfer switch.
- B. Configuration: Electrically operated, mechanically held transfer switch.
- C. Operation: As described in this Section.
- D. Neutral: Same rating as switch contacts. Provide bus with lugs.

2.3 SERVICE CONDITIONS

- A. Service Conditions: NEMA ICS 1.
- B. Temperature: 100°F

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- C. Altitude: 3,300'

2.4 RATINGS

- A. Voltage: As indicated.
- B. Switched Poles: As indicated.
- C. Load Inrush Rating: Combination Tungsten lamp, Electric discharge lamp resistive and motor load.
- D. Continuous Rating: As indicated.
- E. Interrupting Capacity: 100% of continuous rating.
- F. Withstand Current Rating: Refer to schedule for panels or one-line diagram for overcurrent devices which supply normal and standby power. Provide transfer switch which will withstand the let-through current of the source overcurrent devices or provide suitable overcurrent devices to protect the switch.

2.5 PRODUCT OPTIONS AND FEATURES

- A. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION.
- B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
- C. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.
- D. Transfer Switch Auxiliary Contacts: 1 normally open; 1 normally closed contact on the normal switch and an identical pair on the emergency switch.
- E. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85% or frequency varies more than 3 Hertz from rated nominal value.
- F. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85% or frequency varies more than 3 Hertz from rated nominal value.
- G. Exerciser Mode: Transfer switch shall have the ability to be programmed to run with or without load by the end user on site.

2.6 AUTOMATIC SEQUENCE OF OPERATION

- A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
- B. Time Delay to Start Alternate Source Engine Generator: 0 to 3 seconds, adjustable.
- C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
- D. Time Delay Before Transfer to Alternate Power Source: 0 to 3 seconds, adjustable.
- E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
- F. Time Delay Before Transfer to Normal Power: 0 to 60 seconds, adjustable; bypass time delay in event of alternate source failure.

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- G. Time Delay Before Engine Shut Down: In accordance with the standby generator manufacturer's requirements.
- H. Engine Exerciser: Start engine every 7 days; run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period.
- I. Alternate System Exerciser: Transfer load to alternate source during engine exercising period.

2.7 ENCLOSURE

- A. Enclosure: ICS 6
 - 1. Interior Locations: Type 12
 - 2. Exterior Locations: Type 3R
- B. Finish: Manufacturer's standard enamel.

2.8 IDENTIFICATION

- A. Transfer Switch engraved plastic nameplates: Engraving stock, melamine plastic laminate, minimum 1/16" thick for nameplates up to 20 sq. in. and 1/8" thick for larger sizes.
 - 1. Engraved legend shall be black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
- B. Fasteners for Nameplates: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surface is suitable for transfer switch installation.

3.2 PREPARATION

- A. Provide 4" housekeeping pads for floor mounted switches.

3.3 INSTALLATION

- A. Install transfer switches in accordance with manufacturer's instructions.
- B. Consult user for time of week and program the exerciser to transfer load on units.
- C. Provide control wiring required between generator set and transfer switches.
- D. Provide emergency contactors as required.
- E. Provide engraved plastic nameplates for each transfer switch with 1/2" high lettering. Label shall include the following:
 - 1. Transfer Switch Name
 - 2. Amperage, Voltage, Phase, Wire
 - 3. Indicate "Life Safety", "Optional" or "Critical Care"

3.4 MANUFACTURER'S FIELD SERVICES

- A. Check interwiring and instruct Contractor on corrections required.

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- B. Prepare and start systems as required.

3.5 DEMONSTRATION

- A. Provide systems demonstration as required.
- B. Demonstrate operation of transfer switch in normal, and emergency modes.

3.6 TRANSFER SWITCH SETUP

- A. ATS#1 (Life Safety) to be setup as priority.
- B. ATS#2 (Optional) to be setup for transfer 5 min after ATS#1
- C. If the Fire Pump Transfer Switch calls for power, ATS#2 to be switched to the standby position prior to the Fire Pump Switch transferring power.

3.7 INSTRUCTION

- A. Provide a minimum of two hours of instruction to at least two Owner representatives on transfer switch operation.

END OF SECTION 263600

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SECTION 265100 – INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Interior Luminaires and Accessories
- B. Exit Signs
- C. Luminaire Support Components

1.2 REFERENCES

- A. NEMA WD 6 - Wiring Devices-Dimensional Requirements
- B. NFPA 70 - National Electrical Code
- C. NFPA 101 - Life Safety Code
- D. ANSI/IESNA 500 - 1998 - Recommended Practice for Installing Interior Lighting Systems

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section
 - b. A list of all luminaires arranged in order of designation.
 - c. Factory-issued luminaire data sheets to indicate features, finishes and dimensions with the specific items or model number highlighted. Photocopies with handwriting are not acceptable.
 - d. Factory-issued accessory sheets to indicate optional items added to the luminaires with the specific item or model number highlighted. Photocopies with handwriting are not acceptable.
 - e. Color samples for luminaires that require color selection.
 - f. Wiring diagrams for power, signals, and control wiring.
 - g. All warranties for luminaires.
 - 2. Provide the following items if requested by the Engineer:
 - a. Samples
 - b. Footcandle Layouts
 - c. Luminaire Mock-up proposed layout

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Submit a list of all luminaires installed in the system.
- C. Submit data sheets for all luminaires installed with manufacturers operation and maintenance instruction for each type.
- D. Submit replacement parts identification lists and tools required for all luminaire types.
- E. Submit a list of types of cleaners to be used on all luminaire types.

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- F. Submit final As-Built shop drawings.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Conform to requirements of NFPA 101.

1.7 WORK INCLUDED

- A. Conformance: Luminaires shall be manufactured in strict accordance with the Contract Drawings and Specifications.
- B. Specifications and scale drawings are intended to convey the salient features, function, and character of the luminaires only, and do not undertake to illustrate or set forth every item or detail necessary for the work.
- C. Minor details not usually indicated on the drawings nor specified, but that are necessary for the proper execution and completion of the luminaires, shall be included, the same as if they were herein specified or indicated on the drawings.

1.8 COORDINATION

- A. Coordinate luminaires with the Room Finish Schedules for type of ceiling construction. The Electrical Contractor shall be responsible for ordering the proper luminaires and hardware required for installation in or on a specific ceiling.
- B. Coordinate luminaires with Mechanical and Plumbing Contractors and their respective equipment. Conflicts shall be brought to the attention of the Architect prior to installation of the luminaires and ceilings. Conflicts not brought to the Architect prior to installation of luminaires and ceilings shall be the Electrical Contractors responsibility for all costs associated with rework of luminaires, piping, ductwork, and ceiling grid.

1.9 QUALITY ASSURANCE

- A. Materials, equipment appurtenances as well as workmanship provided under this Section shall conform to the highest commercial standard as specified and as indicated on drawings.

1.10 MAINTENANCE MATERIALS

- A. Provide 2 of each special tool required for maintenance.

1.11 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective
 1. Glass and Plastic Lenses, Covers, and Other Optical Parts: Furnish 2 of each type and rating installed.
 2. Globes and Guards: Furnish 2 of each type and rating installed.

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1.12 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Refer to the Luminaire Schedule.

2.2 LUMINAIRES AND COMPONENTS (GENERAL)

- A. Metal Parts: Free of burrs, sharp corners, and edges.
- B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
- D. Reflecting surfaces shall be minimum reflectance as follows:
 - 1. White – 85%
 - 2. Specular – 83%
 - 3. Diffusing Specular – 75%
 - 4. Laminated Silver Metalized Film – 90%
- E. Lenses, Diffusers, Covers and Globes:
 - 1. 100% virgin acrylic plastic, high resistance to yellowing and other changes due to aging, heat, and UV radiation.
 - a. Lens Thickness: At least 0.125" minimum
 - b. UV Stabilized
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
- F. Luminaires subject to damage shall be equipped with approved heavy-duty metal guards.
- G. Luminaires exposed to weather shall be weatherproof, gasketed provided with aluminum boxes and trim of stainless steel, cast aluminum or other non-ferrous material.
- H. Furnish all necessary materials, accessories and any other equipment required for the complete and proper installation and operation of all lighting luminaires included in this contract.
- I. All lighting luminaires to be listed and labeled by UL or other testing agency acceptable to local code and authorities for installation in fireproof or non-fireproof construction, damp or wet locations as required.
- J. Provide luminaires with all associated appurtenances including, but not necessarily limited to, reflectors, lenses and/or louvers, sockets, holders, suspension accessories, pendants, canopies, lumessing boxes, plaster frames and similar items completely wired, assembled, installed, and tested as specified and in the manner indicated.
- K. All troffer-type lighting luminaires shall be designed to completely eliminate light leakage between the luminaire body and doorframe and shall be provided with positive acting, hinge and latch flush doorframes.
- L. Every luminaire symbol shall have a luminaire number unless otherwise directed. In instances where a specific luminaire symbol has not been assigned a luminaire number, provide a complete luminaire of the type and wattage designated for luminaire symbols of similar function and/or as directed by the Architect.
- M. All luminaires shall be UL listed or assembled from UL components.

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- N. Provide lamps for all lighting luminaires furnished in the project. Contractor to verify that lamps installed in luminaires are of the type recommended by the manufacturer.

2.3 LED LUMINAIRES

- A. Die cast or extruded aluminum heat sinks for LED assemblies and drivers.
- B. Comply with LM79/LM80
- C. CCT: 4000K
- D. CRI: 70 or greater
- E. Operating Temperature: -30°C to +40°C
- F. Driver Power Factor: Greater than 0.9
- G. Driver THD: Less than 20%
- H. Provide light emitting diodes with individual injection molded acrylic optics.

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, 70,000 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-stage type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80% 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. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - g. 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.
- C. Wireguards: Provide wireguards for all exit signs located in the Gymnasiums, Locker Rooms, Multi-Purpose Rooms, Electrical Rooms, Mechanical Rooms, Boiler Rooms, and all other areas indicated on the drawings.

2.5 FINISHES

- A. Manufacturer's standard color, unless otherwise indicated in Luminaire Schedule to be "custom color".

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2" steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

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- B. Twin-Stem Hangers: Two, 1/2" steel tubes with single canopy designed to mount a single luminaire. Finish same as luminaire.
- C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated, 12-ga.
- D. Rod Hangers: 3/16" minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- F. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by luminaire manufacturer.
- G. Safety Cables: Install manufacturer's standard safety cable on all luminaires in the Gymnasium.

2.7 EMERGENCY LIGHTING CONTROL DEVICES

- A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure, the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - 1. 120/277 volts, 50/60 Hz, 20-amp ballast rating
 - 2. Push to test button
 - 3. Auxiliary contact for remote test or fire alarm system interface
- B. Manufacturers:
 - 1. WattStopper Model: ELCU-100 or ELCU-200
 - 2. Bodine Model GTD20 or GTD20A
- C. Provide quantities/type as required by application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set all luminaires level, secure, plumb, and square with ceilings and walls according to manufacturer's written instructions or approved shop drawing.
- B. Install lamps in all luminaires. Contractor to verify that lamps installed in luminaires are of the type recommended by the manufacturer.
- C. Support for Luminaires in or on Grid-Type Suspended Ceilings:
 - 1. Troffer Type (i.e. 2x4, 1x4, 2x2):
 - a. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the applications.
 - b. In addition to support clips, provide a minimum of (4) ceiling independently supported rods or wires for each luminaire. Locate at opposite corners of luminaire.
 - c. Provide additional supports as required by manufacturer.
 - 2. Luminaires of sizes less than ceiling grid (i.e. downlights, exit signs):
 - a. Install as indicated on electrical drawings and architectural reflected ceiling plans. Center luminaire in each panel or center luminaire in half of 2x4 panels to allow other half for use by other equipment. Coordinate final luminaire locations with other contractors.
 - b. Provide support of luminaires with at least two metal channels spanning and secured to ceiling tees with supports that are listed for the application.
 - c. In addition, provide at least one independently supported rod or wire from structure to a tab on the light luminaire. Wire or rod shall have breaking strength of the weight of the luminaire at a safety factor of 3.
 - 3. Install luminaires in strict conformance with the ceiling manufacturer's instruction.

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- D. Suspended Luminaire Support: As follows:
 - 1. Pendants and Rods: Where longer than 48", brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- E. Support luminaires according to the luminaire manufacturer's requirements.
- F. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
- G. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- H. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure.
- I. Install recessed luminaires to permit removal from below.
- J. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- K. Install clips to secure recessed grid-supported luminaires in place.
- L. Install wall mounted luminaires, emergency lighting units and exit signs at height as indicated on Drawings or as directed by Architect.
- M. Install accessories furnished with each luminaire.
- N. Adjust aimable luminaires to provide required light intensities.
- O. Provide wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- P. When a dimming LED Driver is specified, provide 0-10V wiring between driver and control device.
- Q. When a DMX Driver is specified, provide DMX wiring between driver and control device.
- R. Program all DMX addresses before installing luminaires. Coordinate addresses with Owner and Control Manufacturer.
- S. Bond products and metal accessories to branch circuit equipment grounding conductor.
- T. Luminaire Locations: Do not scale electrical drawings for exact location of the lighting luminaires. In general, the architectural reflected ceiling plans indicate the proper locations of lighting luminaires.
- U. Appurtenances: Install each luminaire properly and safely. Furnish and erect hangers, rods, mounting brackets, supports, frames, and other equipment required.
- V. Coordination: Furnish lighting luminaires complete with appurtenances required for the proper, safe, and distortion-free installation in the various surfaces in which they appear. Determine surface types from the Architectural drawings.
- W. Install lighting luminaires in strict conformance with the luminaire manufacturer's recommendations and instructions.
- X. Rigidly align continuous rows of lighting luminaires for true in-line appearance.
- Y. Do not install luminaires and/or parts such as finishing plates, lenses, and trims for recessed luminaires until all plastering and painting that may mar luminaires finish has been completed.

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- Z. Mechanical Rooms: Lighting luminaire locations in mechanical and electrical equipment rooms are approximate. Coordinate mounting height and location of lighting luminaires to clear mechanical, electrical, and plumbing equipment and to illuminate adequately meters, gauges, and equipment.
- AA. Concealment: Whenever a luminaire or its hanger canopy is applied to a surface mounted outlet box. Provide a finishing ring to conceal the outlet box.
- BB. Replace blemished, damaged, or unsatisfactory luminaires as directed.

3.2 CONNECTIONS

- A. Ground Lighting Units: Tighten electrical connectors and terminals, including grounding connections, according to manufacturers published torque-tightening values. Where manufacturers torque values are not indicated, use those specified in L 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Tests: Verify normal operation of each luminaire after luminaires have been installed and circuits have been energized with normal power source. Interrupt electrical energy to demonstrate proper operation of emergency lighting system.
- C. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.
- D. Report results of tests.
- E. Replace luminaires that show evidence of corrosion during project warranty period.

3.4 ADJUSTING AND CLEANING

- A. Clean luminaires after installation. Use methods and materials recommended by manufacturer.
- B. Adjust luminaires to provide required light intensities.

END OF SECTION 265100

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SECTION 265600 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Exterior Luminaires and Accessories
- B. Poles

1.2 RELATED WORK/DIVISIONS

- A. Division 3

1.3 REFERENCES

- A. IES RP-8 - Recommended Practice for Roadway Lighting
- B. IES RP-20 - Lighting for Parking Facilities
- C. NFPA 70 - National Electrical Code

1.4 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all luminaires arranged in order of luminaire designation.
 - c. Luminaire data sheets to indicate features, finishes, and dimensions with the specific items or model number highlighted.
 - d. Accessory sheets to indicate optional items added to the luminaires with the specific item or model number highlighted.
 - e. Color samples for luminaires that require color selection.
 - f. Wiring diagrams for power, signals, and control wiring.
 - g. Product certificates for each type of ballast for dimmer-controlled luminaires, signed by the product manufacturer.
 - h. All warranties for luminaires.

1.5 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Submit a list of all luminaires installed in the system.
- C. Submit data sheets for all luminaires and poles installed with manufacturers operation and maintenance instructions for each type.
- D. Submit replacement part identification lists and tools required for all luminaire and pole types.
- E. Submit a list of types of cleaners to be used on all luminaire types.
- F. Submit final As-Built shop drawings.

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1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3 years' experience.

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Transport, handle, store, and protect products.

1.9 COORDINATION

- A. Coordinate site lighting installation with the paving, site grading and underground work by other contractors.
- B. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

1.10 MAINTENANCE MATERIALS

- A. Provide 2 of each special tool required for maintenance.

1.11 EXTRA MATERIALS

- A. Furnish one gallon of touch-up paint.
- B. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Glass and Plastic Lenses, Covers and Other Optical Parts: Furnish 1 of each type and rating installed
 - 2. Globes and Guards: Furnish 1 of each type and rating installed.

1.12 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Refer to the Luminaire Schedule

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

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- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. 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. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning", to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning, or SSPC-SP8 "Pickling".
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA611.
 - 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA611.
- O. Every luminaire symbol shall have a luminaire number unless otherwise directed. In instances where a specific luminaire symbol has not been assigned a luminaire number, provide a complete luminaire of the type and wattage designated for a luminaire symbol of similar function and/or as directed by the Architect.
- P. All luminaires shall be UL listed or assembled from UL components.

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2.3 LED LUMINAIRES

- A. Die cast or extruded aluminum heat sinks for LED assemblies and drivers.
- B. Comply with LM79/LM80
- C. CCT: 4000K
- D. CRI: 70 or greater
- E. Operating Temperature: -30°C to +40°C
- F. Driver Power Factor: Greater than 0.9
- G. Driver THD: Less than 20%
- H. Provide light emitting diodes with individual injection molded acrylic optics.

2.4 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4M.
- 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 2.5" x 5" with cover secured by stainless-steel captive screws.
- E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-In-Place Concrete"

2.5 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 B209 (ASTM B209M), 5052-H34 marine sheet alloy with access handhole in pole wall.
 - 1. Shape: Refer to Luminaire Schedule.
 - 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" 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. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

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2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

2.6 POLE ACCESSORIES

- A. Base Covers: Manufacturers standard metal units, arranged to cover pole's mounting bolts and nuts. Provide 1 for every pole.

2.7 FINISHES

- A. Luminaires: Manufacturers standard color, unless otherwise indicated in the Luminaire Schedule to be "Custom Color".
- B. Poles: Manufacturers standard color, unless otherwise indicated in the Luminaire Schedule to be "Custom Color".
- C. Luminaire and pole assemblies finish shall always be identical.
- D. All accessories and mounting hardware shall match luminaire or pole finish.
- E. Foundation sealer shall be Drylock Extreme Water Proofer, or equivalent by Master Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide a pole for every pole mounted assembly.
- B. Provide concrete bases for all lighting poles in accordance with Division 3.
- C. Install poles plumb. Provide double nuts to adjust plumb. Grout around each base.
- D. Install lamps in each luminaire.
- E. Provide a ground rod in every concrete base.
- F. Bond luminaires, metal accessories and metal poles to branch circuit equipment grounding conductor and ground rod installed in concrete base.
- G. Provide sealing finish of concrete pole bases to hide form lines and air pockets.
- H. When a dimming LED Driver is specified, provide 0-10V wiring between driver and control device.

3.2 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

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- B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 2" above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete".

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 2" above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete".

3.5 GROUNDING

- A. Ground metal poles and support structures according to Section 260526.
 - 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 Section 260526.
 - 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 CONNECTIONS

- A. Ground Lighting Units: Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.7 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.
- C. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source. Measure light intensities at night. Use photometers with calibration referenced to NIST Standards. Comply with the following IESNA testing guide(s):
 - 1. Check intensity and uniformity of illumination.
 - 2. Check excessively noisy ballasts.

3.8 ADJUSTING AND CLEANING

- A. Clean luminaires after installation. Use methods and materials recommended by manufacturer.
- B. Clean electrical parts to remove conductive and deleterious materials.
- C. Remove dirt and debris from enclosure.

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- D. Clean photometric control surfaces as recommended by manufacturer.
- E. Clean finishes and touch up damage.
- F. Adjust aimable luminaires to provide required light intensities.

3.9 PROTECTION OF FINISHED WORK

- A. Protect installed work.

END OF SECTION 265600

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SECTION 270500 – COMMON WORK REQUIRED FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Grounding and Bonding for Communications Systems
- B. Fire Rated Pathways for Communications Systems
- C. Hangers and Supports for Communications Systems
- D. Conduits and Backboxes for Communications Systems

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section
 - b. A list of all equipment to be provided and installed.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. As-Built Drawings: Provide a marked-up copy of original plans which reflect any changes or additions not shown on the plan.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Provide products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project site in manufacturer's original, unopened cartons and containers, each bearing names of product and manufacturer.
- B. Store products in dry spaces protected from the weather. The storage temperature shall be 68°F to 122°F.

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1.8 PLENUM WIRING

- A. This is an air "Plenum" project. Cabling installed in plenums or in areas above hung ceilings, used as a plenum, shall be plenum rated or installed in conduit.

1.9 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

- A. Telecommunications Ground Bus:
 - 1. Material: 1/4" tinned copper busbar
 - 2. Size: As required
 - 3. Mounting: Insulated stand-off
 - 4. Location: All IDF rooms in the project
- B. Ground Wires: Refer to Section 260519 for ground wires

2.2 FIRE RATED PATHWAYS FOR COMMUNICATIONS

- A. Manufacturers:
 - 1. Specified Technologies Inc.
 - a. EZ-PATH Fire Rated Pathway (single, double, and triple)
- B. Pathways:
 - 1. Cables passing through fire-rated floors or walls shall pass through fire-rated wiring devices which contain an intumescent insert material that adjusts automatically to cable additions or subtractions.
 - 2. The device shall have an F rating equal to the rating of the barrier in which the device is installed.
 - 3. Wiring devices shall be capable of allowing a 0 to 100% visual fill of cables.
 - 4. Wire devices shall be of a sufficient size to accommodate the quantity and size of electrical wires and data cables required.
 - 5. Wire devices to be provided with steel wall plates allowing for single or multiple devices to be ganged together.

2.3 FIRESTOPPING

- A. The Contractor shall be responsible for providing permanent, UL approved firestopping systems for all penetrations through fire rated floor or fire rated wall assemblies. For areas that will require future access for the installation of additional cables, repair, or retrofit, the firestopping system shall consist of re-usable intumescent pillows or putty.
- B. Subject to compliance with project requirements, firestopping materials may be provided by one of the following manufacturers:
 - 1. Specified Technologies Inc., (STI) Somerville, NJ (800) 992-1180
 - 2. Tremco, Beechwood, OH (800) 321-7906
 - 3. 3M, St. Paul, MN (800) 328-1687
 - 4. Hilti, Tulsa, OK (800) 879-8000
- C. Submit the following for review and approval:
 - 1. Product data sheets
 - 2. UL System drawings for each firestopping application
 - 3. Manufacturer's Certificates of Conformance for their products

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2.4 HANGERS AND SUPPORTS FOR COMMUNICATIONS

- A. Non-continuous cable supports (J-hooks):
 - 1. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables.
 - 2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
 - 3. Non-continuous cable supports 1-15/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger.
 - 4. Non-continuous cable supports shall have an electro-galvanized finish and be rated for indoor use in non-corrosive environments.
 - 5. Non-continuous cable supports shall be UL listed, with manufacturer's name and part number stamped on.
- B. Wire Rod Type Cable Tray:
 - 1. Refer to Section 260536 for wire rod type cable tray.

2.5 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

- A. Refer to Section 260533 for raceways and boxes.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Verify locations and mounting heights with the communications equipment.

3.2 GROUNDING AND BONDING INSTALLATION

- A. Telecommunications Ground Bus: Connect to the following:
 - 1. Bond to metal water pipe with #6 copper – green insulation. (Provide 1" conduit where run is over 3' away.)
 - 2. Bond to building roof steel with #6 copper – green insulation. (Provide 1" conduit where run is over 3' away.)
 - 3. Ground counterpoise with #1/0 copper – green insulation in 1-1/2" conduit.
 - 4. Main service entrance equipment ground bus with #1/0 copper – in 1-1/2" conduit.
 - 5. IDF rack ground bus with #1/0 copper – (Provide in 1-1/2" conduit when not in cable tray).
- B. IDF Rack Ground Bus shall connect to the following:
 - 1. Bond to rack with #6 copper – green insulation.
 - 2. Building structural steel with #6 copper – green insulation.
- C. Wire Rod Type Cable Tray (Section 260536): Provide #2 bare copper conductor, entire length of cable tray. Bond at 50' intervals.
- D. Identification: Provide tag on each ground conductor at bus to read as follows: "Caution – Ground Wire – Do not Remove". Provide I.D. marking of all conductors as per N.E.C.
- E. Comply with Section 260526, 270500 and applicable details on plans.
- F. Provide connections to the main ground bus on all backboards, telephone line protectors, IDF Racks and MDF Racks in the project.
- G. Connect ground buses with cables per Specification Section 260526, 270500 and applicable details on plans.

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3.3 FIRESTOPPING

- A. Penetrations in fire rated partitions shall be sealed to maintain the fire integrity of the assembly. Provide fire stopping meeting the same rating as the assembly being sealed.
- B. All firestopping shall meet the requirements of ASTM E-814 and UL 1479.
- C. Comply with all installation requirements of Division 7.

3.4 HANGERS AND SUPPORTS INSTALLATION

- A. Provide supports as required to support all communications cabling.
- B. Provide cable tray as required to support all communications cabling.
- C. Comply with all installation requirements of Sections 260529 and 260536.

3.5 CONDUITS AND BACKBOXES INSTALLATION

- A. Provide raceways and boxes as required for communications cabling.
- B. Comply with all installation requirements of Section 260533.
- C. Except for recessed outlet boxes in masonry walls or communication outlets provided in a shared outlet box with a wiring device (i.e., receptacle) using an internal outlet box partition, the minimum outlet box size consist of two or larger-gang box with a minimum depth of 2-3/4 inches, inclusive of any mud and/or tile ring depth, unless otherwise noted. Provide mud and/or tile ring with appropriate gang opening size as required. Communication outlet boxes installed recessed in masonry walls shall be a single or larger-gang outlet box with a minimum on 2-3/4 inches will be permitted unless otherwise noted.
- D. The minimum conduit size for communication conduit pathways and stub-outs shall be 1-inch.

3.6 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2" above finished floor level.
- G. Size pipe sleeves to provide 1/4" annular clear space between sleeve and pathway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

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- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
- K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1" annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.7 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 COMMUNICATIONS SYSTEM WIRING METHODS

- A. Provide communication pathways as required in accordance with the following paragraphs. Where communication wiring is required by other specification sections, provide communications wiring in accordance with the following paragraphs.
 - 1. Wire Routing: Route all device wiring from each device up into accessible ceiling cavity within metallic conduit in recessed or unfinished areas and within surface raceway for renovated non-fishable areas. Stub all conduits into accessible ceiling cavity and provide bushing for each.
 - 2. Cable Routing: Route cable for all device wiring within accessible ceiling cavities. Install cable supports at 4' spacing maximum or in cable tray where applicable. No cabling is to lie on or attach to ceiling tile, ducts, pipes, conduits or ceiling suspension wires, rods, or structural members. Provide conduit stubs from devices and panels to the ceiling cavities. Use cable tray for support when it is shown on the drawings.
 - 3. Route all system wiring from system equipment within metallic conduit up into nearby ceiling cavity and connect to the wiring system indicated in 1 and 2 above. Provide bushings at conduit ends.
 - 4. Provide raceways for all communications cabling in all open structure ceiling spaces.
 - 5. Refer to individual sections for methods specific to that system.

3.9 CEILING TILE REMOVAL

- A. The Contractor shall remove and replace ceiling tile and grid work as required for the installation of communications cabling. Damaged tile and grid shall be replaced by the Contractor and shall match the existing ceiling system.

END OF SECTION 270500

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SECTION 271100 – COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment Racks/Enclosures
- B. Backboards
- C. Wire Management
- D. Labeling

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code
- B. NEMA WD-6: Wiring Devices - Dimensional Requirements
- C. EIA 310-D: Cabinets, Racks, Panels, and Associated Equipment
- D. ANSI/ICEA S-80-576: Industry Color Codes

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate dimensions, knockout sizes, material, fabrication details, finishes and accessories with specific item or model number highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. As-Built Drawings: Provide a marked-up copy of original plans which reflect any changes or additions not shown on the plan.
- C. Submit manuals indicating enclosures, accessories, and spare parts.
- D. Record actual locations of racks, equipment, and sizes of pathways.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Supplier: Authorized or Franchised distributor of specified manufacturer with minimum three years documented experience.

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- C. Installer: Authorized or franchised installer of specified manufacturers with five years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Provide products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.7 COORDINATION

- A. Coordinate work of this section with telephone switch.
- B. Adjust arrangements and locations of equipment racks, cabinets, backboards, patch panels, and cross connects in IDF/MDF Rooms and consolidation points to accommodate and optimize arrangement and space requirements. Review revised layouts with Engineer before proceeding with work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project site in manufacturer's original, unopened cartons and containers, each bearing names of product and manufacturer.
- B. Store products in dry spaces protected from the weather. The storage temperature shall be 68°F to 122°F.

1.9 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 WALL-MOUNT PIVOTING EQUIPMENT RACKS

- A. Manufacturers:
 - 1. Middle Atlantic Products Model DWR-X-22 Series
 - 2. Atlas Soundolier
 - 3. Hoffman
- B. Basis of Design – Middle Atlantic Products
 - 1. Model: DWR-35-22
 - 2. Type: 19" wall-mount rack.
 - 3. Compliance: EIA/TIA 310D.
 - 4. UL Listed: US
 - 5. Overall Dimensions:
 - a. Overall Width: 23.40"
 - b. Overall Height: 68.25"
 - c. Overall Depth: 22.3"
 - 6. Useable Dimensions:
 - a. Useable Racking Height: 61.25"
 - b. Useable Depth: 20", extends into backpan 3.5"
 - 7. Rackspaces: 35 space minimum
 - 8. Weight Capacity: 300 pounds
 - 9. Mounting: Tool-free "Quick-Mount" system for one-person mounting of center section to backpan at site
 - 10. Center Section and Backpan:
 - a. 16-gauge steel

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- b. Finish: Black-textured powder coat
 - 11. Corner Braces: 1/8" thick
 - 12. Rackrail:
 - a. 11-gauge steel with tapped 10-32 mounting holes in universal EIA spacing
 - b. Finish: Black e-coat
 - c. Rackspaces: Marked
 - 13. Backpan: Raised mounting embosses to mount power products and other accessories
 - 14. Rack: Swing open for component cabling access
 - a. Center Section: Pivot for left or right opening
 - 15. Knockouts:
 - a. Center Section:
 - 1) Decora Knockouts: Top and bottom of face
 - 2) Fan Knockouts: Top and bottom, each accepts up to two 4-1/2" fans
 - b. Backpan:
 - 1) Electrical Knockouts: Top and bottom, 3/4", 1", 1-1/2", 2", and 3"
 - 2) BNC Knockouts: Top and bottom, 5/8" UHF/VHF antenna knockouts
 - 3) Laser Knockout: Backpan, 12-1/2" by 12" opening for through-wall cable pass-through
 - 4) UCP Knockouts: Locking side of backpan accepts 1 UCP panel
 - 16. Top, Bottom, and Sides: Vertical vent pattern, center section
 - 17. Lacing Points: Throughout interior to facilitate cable management
 - 18. Latch: Pad lockable
 - 19. Keylock: Standard 1/4 turn
 - 20. Grounding and Bonding Studs: 1/4-20 by 1" threaded, installed in center section and backpan
- C. Provide the following accessories for **ALL** racks unless otherwise noted on the Drawings:
- 1. Front Door: Reinforced 16-ga steel, vented, 64% open area, Model LVFD-XX
 - a. Hinges: Zinc die cast, can be installed while rack is fully loaded with equipment
 - 2. Rear Rail Kit: 11-ga steel, 10-32 threaded, pair, includes hardware, Model DWR-RR35
 - 3. Fan Kit: Two 4-1/2" exhaust fans, fan guards and vent blockers, Model DWR-FK22
 - 4. Zero-Clearance Latch: Allows close proximity mounting, Model DWRSR-ZL
 - 5. All equipment mounting hardware required
 - 6. Blank and vented panels to fill rack
- D. Power Outlet Strips:
- 1. Provide (1) AC power outlet strips with 9 NEMA 5-20R (20A) outlets and line cord mounted horizontally in enclosure, Model PD-920R.

2.2 BACKBOARDS

- A. Fire retarded grade southern yellow pine or fir plywood with exterior glue, 3/4" thick, size as shown or required.
- B. Paint with 1 coat of exterior wood primer both faces and all edges and 1 coat of light gray semi-gloss enamel on the front face only.

2.3 HORIZONTAL WIRE MANAGEMENT

- A. Manufacturers:
 - 1. Hubbell Premise Wiring
 - 2. Middle Atlantic Products
 - 3. Hoffman
 - 4. Great Lakes
- B. Basis of Design – Hubbell Premise Wiring Horizontal Cable Managers
- C. Design Requirements:
 - 1. Horizontal cable management panel shall be all steel with black powdercoat finish.
 - 2. Horizontal cable management panel shall feature (5) cable management rings on front and back constructed of flat steel for maximum cable support.

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3. Horizontal cable management duct (Models HS13C or HS23C) shall feature hinged front steel covers.
4. Black powder coating shall comply with all applicable ASTM standards for exposed metal, and resistance to flaking, cracking, or chipping.

2.4 IDENTIFICATION

- A. Engraved plastic nameplates: Engraving stock, melamine plastic laminate, minimum 1/16" thick for nameplates up to 20 sq. in. and 1/8" thick for larger sizes.
 1. Engraving legend shall be black letters on white face.
 2. Punched or drilled for mechanical fasteners.
- B. Fasteners for Nameplates: Self-tapping, stainless-steel screws or #10/32 stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Provide horizontal and vertical cable management in all racks, on all backboards and any other location cabling is not routed in conduit or cable tray. Size cable management for 50% additional cables.
- B. Wiring within IDF/MDF and Enclosures: Provide adequate length of conductors. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- C. Install a 1 rack unit blank filler plate between patch panels which contain more than 12 jacks.
- D. Provide blank filler plates as required to fill rack.
- E. Support raceways, cabinets, and all other equipment in accordance with manufacturer's instructions.
- F. Install backboards and cabinets plumb and attach securely to building wall at each corner and additional as necessary to obtain a firm mounting.
- G. Provide full assembly of all racks, equipment enclosures, cabinets and file servers with all accessories installed.
- H. Provide engraved plastic nameplates for each equipment rack and equipment enclosure with 1/2" high lettering. Label shall include the following:
 1. Equipment Rack or Equipment Enclosure Name

3.3 GROUNDING

- A. Comply with Section 260526, 270500 and applicable details on plans.
- B. Provide connections to the main ground bus on all backboards, telephone line protectors, IDF Racks and MDF Racks in the project.

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- C. Connect ground buses with cables per Specification Section 260526, 270500 and applicable details on plans.

END OF SECTION 271100

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SECTION 271300 – COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fiber Optic Cables and Equipment

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code
- B. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises
- C. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard
- D. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard
- E. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard
- F. BISC1 – Telecommunications Distribution Methods Manual (Current Edition)
- G. ANSI/TIA/EIA-607-C – Grounding and Protection of Telecommunication Cables and Equipment
- H. EIA/TIA-604-3: Fiber Optic Connector Internoteability Standard
- I. ANSI/ICEA S-80-576: Industry Color Codes
- J. UL 910/NFPA 262: Test method for fire and smoke characteristics of electrical and optical-fiber cables used in air handling spaces.
- K. UL 1666: Flame propagation height of electrical and optical-fiber cables installed vertically in shafts.

1.3 SYSTEM REQUIREMENT

- A. All cables specified are to be supplied in “Plenum-Rated” versions for this installation.
- B. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum performance.

1.4 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following;
 - a. Reference to Specification Section
 - b. A list of all equipment to be provided and installed.
 - c. Data sheet to indicate each cable type including number of pairs, punch down block, outlet/connectors with the specific item or model number highlighted.
 - d. Data sheets to indicate supply dimensions, ETL-verified electrical characteristics and parameters, upgrade/expansion data, and mounting methods for all hardware and materials with the specific item or model numbers highlighted.

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- C. Submit manufacturer warranty certificate stating length of warranty, other accepted component manufacturers and overall testing/replacement responsibility.
- D. Submit product certificates signed by manufacturers of cables, connectors, and equipment certifying that products furnished comply with requirements and warranty is valid with equipment installed.
- E. Submit evidence that all qualifications have been met.
- F. Submit make/model numbers of testers to be used for all testing of cables.

1.5 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. As-Built Drawings: Provide a marked-up copy of original plans which reflect any changes or additions not shown on the plan. Identify all cable and jack numbering as identified on site and in System Final Test Report. Indicate routing of all IDF to MDF cabling.
- C. Submit Test Report for each basic link from patch panel to jack/patch panel. Report to include test equipment type and calibration data, date, and operator.
- D. Submit electronic copy of final comprehensive schedules for project, in software and format selected by Owner.
- E. Record actual locations of outlets and sizes of pathways.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Supplier: Authorized or Franchised distributor of specified manufacturer with minimum three years documented experience.
- C. Installer: Authorized or franchised installer of specified manufacturers with five years documented experience.
- D. Installer must be able to identify and correct non-compliance in structured cabling systems. Provide the name of a fulltime RCDD employed by the installing company.
- E. Provide satisfactory evidence of a fully equipped service organization, capable of furnishing adequate inspection and service to the system, including standard replacement parts within 50 miles of the project site.
- F. Perform all terminations at device and headend locations using the hereby qualified installation firm.
- G. Supervise and approve all cable pulls in accordance with warranty requirements of the certifying company.

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Provide products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

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1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project site in manufacturer's original, unopened cartons and containers, each bearing names of product and manufacturer.
- B. Store products in dry spaces protected from the weather. The storage temperature shall be 68°F to 122°F.

1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of complete telecommunications backbone cabling system for one year from Date of Substantial Completion of project at no additional cost to Owner.

1.10 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 FIBER OPTIC ENCLOSURES

- A. Manufacturers:
 - 1. Hubbell Premise Wiring
 - 2. The Siemon Company
 - 3. Systimax GigaSpeed Products
 - 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring FCR Series Rack Mount Fiber Panels
- C. Design Requirements:
 - 1. Enclosure design shall be a modular, rack-mounted, powder coated formed cold rolled steel enclosure with a non-removable front cover, L shaped removable slide out cover panel, and slide-out inner tray.
 - 2. Each basic unit delivered shall consist of: (1) enclosure assembly, (2) installed mounting brackets, (4) #10-32 rack mounting screws, (1) splice tray stud, and an accessory kit containing hardware, cable management accessories, and label sheets.
 - 3. Material shall be as follows:
 - a. Enclosure, panels, and tray: 16-ga cold rolled steel (CRS)
 - b. Mounting brackets: 13-ga CRS
 - c. Front cover: smoke-tinted Lexan plastic
 - 4. Basic dimensions of the enclosures shall be approximately 17" wide by 17" deep.
 - 5. Enclosures shall be available in heights of 1.75" (1RU), 3.5" (2 RMU), 5.25" (3 RMU), and 7" (4 RMU) versions.
 - 6. Finish shall be black durable powder coat on all metal surfaces.
 - 7. Front door shall be smoke-tinted Lexan plastic, hinged at the bottom,
 - 8. Front door shall be secured in the closed position with magnetic closing operation.
 - 9. One-piece top and rear cover shall be removable, without fasteners, to provide access to the connector field.
 - 10. Enclosure shall be equipped with panel-mounting brackets assembled for 19" rack mounting, compliant to ANSI/EIA-310-D.
 - 11. Panel mounting brackets shall be configurable to either 19" or 23" racks.
 - 12. Enclosure chassis shall have two mounting bracket locations for either 5" or 7" center mount on the rack.
 - 13. Rear of enclosure shall have knockouts, on each side, for backbone cable entry and internal routing.
 - 14. Front of enclosure chassis shall have side cutouts for patch cord entry into and exit from the enclosure.
 - 15. Inner tray shall slide out in the forward direction by releasing the lever-action quick-release latches. Tabs in the chassis shall engage with slots in the inner tray in the outward position to prevent tray from falling out.

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16. Inner tray panel mounting posts shall accept modular adapter panels, in high- or low-density versions. Adapter panels shall be available in a range of adapter types for multimode and singlemode applications.
17. Inner tray shall have clips for cable ties, and holes to accept snap-in cable clips, front and rear, for complete cable management of patch cords and distribution cable strands.
18. Inner tray shall have rear cable tie-down features to accept various diameter backbone cables entering the enclosure.

D. Provide fiber panel sized for adapter panels + 20% spare.

2.2 FIBER OPTIC ADAPTER PANELS

A. Manufacturers:

1. Hubbell Premise Wiring
2. The Siemon Company
3. Systimax GigaSpeed Products
4. Leviton

B. Basis of Design – Hubbell Premise Wiring FSP Series Fiber Adapter Panels

C. Design Requirements:

1. Fiber adapter panels shall be a modular, quick-fastening steel plate, powder coated to match the enclosure finish.
2. Fiber adapter panels shall have pre-installed LC fiber adapters, available in low- or high-density multi-mode or single-mode applications.
3. Each individually bagged unit delivered shall consist of: (1) fully assembled adapter panel, with push-pull fasteners pre-installed.
4. Adapter panels shall be constructed of 16-ga cold rolled steel.
5. Finish shall be black durable powder coat on all surfaces.
6. Basic dimensions of the FSP panels shall be 5.10" length by 1.10" wide.
7. Panels shall have two pre-installed, push-pull type quick-release fasteners for quick snap-in installation. Push-pull fasteners shall have an industry standard center distance of 4.65".
8. Panels shall be suitable for mounting either vertically or horizontally.
9. Panels shall be available in with LC adapters with precision ceramic alignment sleeves.
10. All fiber adapters installed in FSP panels shall have dust caps installed.
11. Panels shall be available in low-density and high-density adapter patterns.

D. Fiber optic cable shall be terminated with LC OM3 50/125um Multimode (LC OM4 50/125um Multimode as required by distance application parameters) or LC OS2 Singlemode connectors to fiber adapter panels mounted in Hubbell FCR series fiber optic enclosures with at least 50% spare capacity.

E. Provide port quantities to match the fiber optic cables + 20% spare unless otherwise noted on the Drawings.

2.3 FIBER OPTIC CONNECTORS

A. Manufacturers:

1. Hubbell Premise Wiring
2. The Siemon Company
3. Systimax GigaSpeed Products
4. Leviton
5. Corning

B. Basis of Design – Hubbell Premise Proclick, Pre-polished FCLC900K or FCSC900K Series Type Connectors: Hubbell Splice-On Connectors are also acceptable to maintain the 25-year fiber warranty. PN#'s FCLCF900M50G6OK, FCLCF900SM6PK, FCSCF900M50G6PK, FCSCF900SM6PK.

C. Fiber optic cable shall be terminated with LC OM3 50/125um Multimode (LC OM4 50/125 um Multimode as required by distance application parameters) or LC OS2 Singlemode connectors to fiber adapter panels mounted in Hubbell FCR series fiber optic enclosures with at least 50% spare capacity.

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D. Design Requirements:

1. Connector basic design shall be a factory pre-polished LC optical fiber connector with a zirconium ceramic ferrule. Integral with the connector body is a wedge-activated fiber clamping mechanism to secure the inserted fiber into a mechanical splice with the factory installed cleaved fiber stub. Index-matching gel is supplied factory-injected into the cleaved fiber stub splice to optimize transmission performance. Connector attachment is achieved without tools, by inserting a field-cleaved optical fiber and then extracting the disposable clamp wedges from the connector body.
2. Each basic connector unit delivered shall consist of: (1) connector body with disposable clamp wedge, (1) strain relief boot, and (1) plastic dust cap.
3. LC multimode factory pre-polished connectors shall be 50-micron laser optimized pre-installed fiber.
4. Connector termination method shall utilize an industry standard multi-layer strip tool and bare fiber cleave tool as the only field tools required.
5. LC connectors shall have features to enable field verification using a Visual Fault Locator (VFL) during termination.
6. Connector materials shall be designed with thermal stability to comply with environmental requirements of ANSI/TIA/EIA-568-C.3 and Telcordia GR-1081-CORE.
7. Multimode and singlemode pre-polished fiber connector materials shall be as follows:
 - a. Ferrule: zirconium ceramic
 - b. LC inner body: thermally stable injection molded thermoplastic
 - c. Dust Cap: nylon or PVC
 - d. Strain relief boot: UL94-V0 molded PVC
8. Pre-polished LC connectors shall require no field polishing.
9. Pre-polished MM LC connector body shall be industry standard aqua for 50-micron multimode, laser optimized colors for specific applications, as designated below:
10. Pre-polished MM LC connectors shall require no adhesives for termination.
11. LC connector internal fiber clamping mechanism shall firmly secure both the inserted glass fiber and the 900-micron buffer layer of the inserted fiber for maximum strain relief.
12. All standard mating and interface dimensions for LC connectors shall comply with ANSI/TIA/EIA-604-10 (FOCIS 10).
13. Ferrule outside diameter for LC multimode connectors shall be 1.2467mm to 1.2497mm.
14. Ferrule outside diameter for LC singlemode connectors shall be 1.2483mm to 1.2497mm.
15. LC ferrule tip shall have a PC spherical radius of approximately 7.0 mm radius for multimode and singlemode versions.
16. Delivered connectors shall be individually bagged with the dust cap installed to protect from contamination.
17. Delivered connectors shall have the disposable clamp activation wedge element pre-installed onto the connector body.
18. Connector design and termination technique shall be independent of cable type or manufacturer and shall be compatible for either 900-micron buffer or 250-micron buffer distribution cables.
19. LC connector strain relief boot shall be a Telcordia style slotted design for maximum flexural strain relief.
20. Strain relief boot shall be black for multimode, and yellow for singlemode.
21. LC connectors shall be available individually bagged in packs of 12.
22. Pre-polished LC fiber connectors, when properly installed onto qualified cable, shall meet the 10 Gb/s Ethernet performance requirements of IEEE802.3.
23. Pre-polished LC fiber connectors, properly installed onto qualified cable, shall exceed the mechanical and environmental performance requirements of ANSI/TIA/EIA-568-C.3, Annex 'A'.
24. Pre-polished LC fiber connectors, properly installed onto qualified cable, shall exceed the mechanical and environmental performance requirements of Telcordia GR-1081-CORE.
25. Qualification test data shall be available from the manufacturer upon request.

2.4 SINGLE MODE FIBER OPTIC CABLES

A. Manufacturers:

1. Hubbell Premise Wiring
2. The Siemon Company
3. Systimax GigaSpeed Products
4. Corning
5. Belden
6. Berk-Tek, Inc.

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- B. Basis of Design – Hubbell Premise Wiring HFCD19 Series Indoor/Outdoor Fiber Optic Cable
- C. Optical Fiber Indoor/Outdoor Distribution Cable, Cable Requirements
1. Optical Fiber Indoor/Outdoor Distribution Cable shall be constructed with 12 optical fibers unless otherwise noted on the Drawings, each coated with a 900-micron color-coded PVC tight buffer, surrounded by an aramid yarn strength member, and an armored outer jacket with the appropriate flame rating.
 2. Fiber cables shall be a non-metallic construction, OFNP (Plenum FT-6) flame rating.
 3. Cable markings shall repeat every meter, and shall have at minimum the following information:
 - a. Sequential length indicator marking (meters)
 - b. Lot number, traceable back to the fiber draw lot
 - c. Date of Manufacture
 - d. Fiber type: (Singlemode)
 - e. Cable rating (OFNR, OFNP, etc.)
 - f. Applicable Telcordia, TIA, IEC, and ICEA standard references and appropriate UL/CSA agency listings
 4. Cable jacket colors shall conform to the following industry standard conventions:
 - a. Yellow: Singlemode
 5. Buffer position color codes shall conform to standard ICEA and TIA-598 conventions as follows: 1-Blue, 2-Orange, 3-Green, 4-Brown, 5-Slate, 6-White, 7-Red, 9-Yellow, 10-Violet, 12-Aqua.
 6. Optical fiber in any cable construction shall be enhanced performance, bend-insensitive type.
 7. Singlemode cables shall perform at minimum to the attenuation, bandwidth, and distance application parameters in the table below.

Singlemode Fiber Gigabit and 10 Gigabit Ethernet Application Chart					
Application	Wavelength (nm)	Max Attenuation (dB/km)	Bandwidth (MHz•Km)	1 GbE Distance (m)	10 GbE Distance (m)
1000BASE-LX	1310	0.35	> 1000	5000	n/a
10GBASE-L	1310	0.35	> 1000	n/a	10,000
10GBASE-E	1550	0.25	> 1000	n/a	40,000
10GBASE-LX4	1310	0.35	> 1000	n/a	10,000

8. Optical fiber cables as supplied shall meet or exceed the applicable IEC 60793-1 qualification test requirements for optical, geometry, mechanical, and environmental parameters as specified, and tested in accordance with TIA/EIA-455.
 9. For installed fiber cables, all fiber strands shall pass insertion loss and return loss in accordance with test methods ANSI/TIA/EIA-526-14 for multimode cables.
 10. Installed fiber cables shall exceed all currently ratified bandwidth-distance- application performance parameters for IEEE 802.3ae (10 GbE) and for IEEE 802.3ba (40/100 GbE)
 11. Plenum cables shall be rated UL NFPA-262/UL910/CSA FT-6
- D. Provide combination multimode/single mode cables when indicated.
- E. All fibers shall be terminated in Fiber Connectors with LC or SC connectors as required to match patch panels. Re-terminate existing fiber optic cables as required to make compatible with new patch bays.

2.5 SINGLE MODE FIBER OPTIC PATCH CORDS

- A. Manufacturers:
1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring DFPCLCLCS (SM) Series patch cords.

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- C. Fiber optic cable shall be terminated with LC OS2 Singlemode connectors to fiber adapter panels mounted in Hubbell FCR series fiber optic enclosures with at least 50% spare capacity.
- D. Design Requirements
1. LC duplex optical fiber patch cords shall be constructed with aramid-reinforced PVC loose-jacket duplex cable, with optical fibers having a 900-micron PVC buffer coating diameter.
 2. Single Mode OS2 core optical fiber within the patch cord cable shall be graded index type in accordance with ANSI/TIA/EIA-492AAAC, with the following specifications:
 - a. Core diameter: 9 ± 1.0 microns
 - b. Cladding diameter: 125 ± 2.0 microns
 - c. Core/cladding concentricity: less than 3.0 microns
 - d. Core non-circularity: 6% maximum
 - e. Proof test: 100 kpsi
 - f. Effective modal bandwidth: 2000 MHz•km
 - g. Coating diameter: 245 ± 15 microns
 - h. Buffer diameter: 900 microns nominal
 3. Connector terminations on each end of the fiber patch cord shall be heat-cured epoxy type with a machine polish, inspected 100% for polish quality and mated-pair insertion loss.
 4. Epoxy volume within each connector shall be sufficient to properly surround and strain relieve the fiber and buffer layer at the buffer/fiber transition inside the connector body.
 5. Optical fiber patch cords shall be supplied in a sealed plastic bag with dust caps installed on each end, with insertion loss test results included.
 6. Optical fiber patch cords shall be available in standard lengths of 1, 2, 3, and 5 meters. Special lengths shall be available on a make-to-order basis.
 7. Optical fiber patch cords shall be manufactured with industry standard LC connector terminations on each end.
 8. Factory mounted connectors on each end of the patch cords shall comply with the applicable ANSI/TIA/EIA-604 Interchangeability standard.
 9. Buffered fiber strands within the cable jacket shall be surrounded by aramid (Kevlar) material serving as a strength member.
 10. The aramid (Kevlar) strength member shall be mechanically secured at each connector to provide tensile strain relief of the optical fiber.
 11. Additional strain relief of the buffered fiber shall result from crimping the rear of the connector during termination.
 12. LC Duplex fiber patch cords shall be a zip-cord cable construction with jacket cross-section dimensions of 1.6 mm X 3.0 mm.
 13. Duplex fiber patch cords shall have reverse-pair polarity according to ANSI/TIA/EIA-568-C.3 and TIA/EIA-TSB-125.
 14. Cable jacket shall be marked with the cable manufacturer, UL Optical Fiber Non-Metallic Riser rating (Type OFNR) designation, lot number, and fiber core/cladding diameter designation.
 15. Fiber A-B polarity shall be clearly marked on each end of duplex patch cords.
 16. Optical fiber patch cord jacket color shall be yellow, specifically for Singlemode OS2 laser optimized multimode fiber cables.
 - a. Fiber patch cord connector materials shall be as follows:
 - b. Ferrules: zirconium ceramic
 - c. Housings: injection molded thermoplastic
 - d. Dust Cap: nylon or PVC
 - e. Strain relief boot: UL94-V0 molded PVC
 17. SingleMode OS2 laser optimized patch cords shall have a maximum mated-pair insertion loss of 0.60 dB per end, with a minimum return loss of -20 dB.
 18. Fiber patch cords shall exceed 10 Gigabit Ethernet performance requirements of IEEE 802.3 standard.
 19. Fiber patch cords shall exceed the mechanical reliability requirements for tensile, flex, twist and impact as specified in ANSI/TIA/EIA-568-C.3
 20. Fiber patch cords shall exceed the environmental reliability requirements for high/low temperature and humidity as specified in ANSI/TIA/EIA-568-C.3
- E. Provide one patch cable for every connected patch panel port. Provide length as required to terminate between fiber patch panels/outlets and equipment in a neat and workmanlike manner through cable management assemblies.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install all cables in accordance with equipment manufacturer's instructions, and with recognized industry practices, to ensure the installation complies with requirements of the NEC, ANSI/TIA/EIA-568-C.1 Commercial Building Telecommunications Cabling Standard and BICSI'S "Telecommunication Distribution Methods Manual" (current edition).
- B. Install all cables only when the temperature is between 32°F to 122°F.
- C. Wiring Method: Wiring shall be installed in EMT conduit within walls and above inaccessible ceilings. Wiring shall be installed in cable tray where it is present. Wiring installed above accessible ceilings between ceiling mounted devices or conduit stub-ups and the cable tray shall be exposed and supported by J-hooks, spaced a maximum of 5'-0" on center, with minimum 1" flat bearing surface. Provide conduit sleeves, bushings and fireproofing through all wall penetrations. All wiring not in EMT conduit shall be kept a minimum of 6" away from all lighting fixtures, motors, and transformers. Cables cannot be ty-wrapped or stapled to ceiling or structural supports, conduit, or other items.
- D. Test each cable as detailed in specification. Include patch cord in test channel.
- E. Identify all cables with a neatly typed label as detailed in specification.
- F. Provide horizontal and vertical cable management in all racks, on all backboards and any other location cabling is not routed in conduit or cable tray. Size cable management for 50% additional cables.
- G. For buildings with floors in excess of two, provide a 2' diameter service loop (with 3 loops) in all between-floor fiber optic cables. Locate one service loop in ceiling cavities of each floor above the lowest floor for future changes/upgrades. Neatly cable tie service loop to structure or cable tray to prevent susceptibility to damage.
- H. Install cable without damaging conductors, shield, or jacket, do not use unjacketed pairs for jumpers.
- I. Do not bend cable in handling or in installing to smaller radii than minimums recommended by manufacturer.
- J. No splicing is permitted for fiber optic cables or telephone high pair count cables. Cables must be continuous between termination points. Make splices, taps and terminations only at indicated outlets, terminals, cross-connect and patch panels.
- K. Provide at least 10' of cable slack at MDF or IDF closet. This slack may be stored in the cable tray or a cable management device behind the MDF/IDF.
- L. Provide 2' diameter in service loops or use figure-8 or serpentine.
- M. Pull cables without exceeding cable manufacturers recommended pulling tensions.
 - 1. Pull cables simultaneously if more than one is being installed in the same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway.
- N. Install exposed cable parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.

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- O. Secure and support cable at intervals not exceeding 5'-0" and not more than 1'-0" from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- P. Wiring within IDF/MDF and Enclosures: Provide adequate length of conductors. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- Q. Separation of Wires: Comply with EIA/TIA-569 rules for separating unshielded copper telecommunications equipment cables from potential EMI sources, including electrical power lines and equipment.
- R. Install fiber optic cables leaving the building in innerduct inside conduit. Provide multiple innerducts in larger conduits.
- S. Support innerduct at manufacturers recommended intervals using manufacturer approved methods.

3.3 GROUNDING

- A. Comply with Section 260526 and applicable details on plans.
- B. Provide connections to the main ground bus on all backboards, telephone line protectors, IDF Racks and MDF Racks in the project. Connect to ground buses with cables per Specification Section 260526 and applicable details on plans.

3.4 FINAL TESTING AND INSPECTION

- A. Provide testing in accordance with ANSI/TIA/EIA-568-C.1.
- B. Cable Test: Provide prior to substantial completion, a Performance Evaluation Report, which will contain the following:
 - 1. Cable Test: List by cable number each Fiber Optic Cable in the project, which details:
 - a. Fiber Optic Cables:
 - 1) Cable ID Number
 - 2) Final measured attenuation in dB/Km
 - 3) List any discrepancies with the fiber installation (bad terminations, faulty labeling, etc.)
 - 2. Test Method: All fiber cabling to be tested as follows: Fiber Testing: Cable to be factory pre-tested on a reel basis for all fiber on this project. The attenuation in dB/Km to be recorded in Final Test Report. Contractor must test each fiber after installation using Power Meter. A dB Printout, end to end with connectors attached to be made and provided as part of the "Performance Evaluation Report". Traces must depict actual fiber loss (dB/Km), fiber length (ft.) and any fiber irregularities. Runs over 1,000' must be tested using an optical time domain refractometer (OTDR). Test horizontal cables when installed and terminated as follows:
 - a. Both Wavelengths
 - b. One Direction
 - c. Link Loss <8.5 dB, 200 meters
 - d. Test centralized cables from utility entrances (typically single mode) as follows:
 - 1) One Wavelength
 - 2) One Direction
 - 3) Link Loss <3.3 dB for 300 meters.
 - 3. System Performance Report: Provide a narrative detailing the system as a whole in regard to the quality of installation and any discrepancies affecting performance. This narrative to indicate a summary of the above Cable Test, as well as an accurate summary of specified Category performance as well as capability of the cabling system to perform at specified Category bandwidth.

3.5 WARRANTY

- A. The installation shall be provided with a minimum 25-year warranty for strict compliance with the performance requirements of ANSI/TIA/EIA-568-C.1 to support and conform to ANSI/TIA/EIA-568-C.1 specifications covering any current or future application which supports transmission over a properly constructed horizontal

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cabling system premises network which meets the channel performance as described in ANSI/TIA/EIA-568-C.2.

END OF SECTION 271300

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SECTION 271500 – COMMUNICATIONS HORIZONTAL CABLING – CATEGORY 6

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. UTP Cables and Equipment
- B. Modular Jacks, Modules and Faceplates
- C. Surface Mount Boxes
- D. Cord Reels
- E. Phone Plates
- F. Labeling

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code
- B. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises
- C. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard
- D. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard
- E. BISC1 – Telecommunications Distribution Methods Manual (Current Edition)
- F. NEMA WD-6: Wiring Devices - Dimensional Requirements
- G. ANSI/TIA/EIA-607-C – Grounding and Protection of Telecommunication Cables and Equipment
- H. ANSI/ICEA S-80-576: Industry Color Codes
- I. UL 910/NFPA 262: Test method for fire and smoke characteristics of electrical and optical-fiber cables used in air handling spaces.
- J. UL 1666: Flame propagation height of electrical and optical-fiber cables installed vertically in shafts.

1.3 SYSTEM REQUIREMENT

- A. All cables specified are to be supplied in "Plenum-Rated" versions for this installation.
- B. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum performance.

1.4 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following;

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- a. Reference to Specification Section
 - b. A list of all equipment to be provided and installed.
 - c. Data sheet to indicate each cable type including number of pairs, punch down block, outlet/connectors with the specific item or model number highlighted.
 - d. Data sheets to indicate supply dimensions, ETL-verified electrical characteristics and parameters, upgrade/expansion data, and mounting methods for all hardware and materials with the specific item or model numbers highlighted.
- C. Submit manufacturer warranty certificate stating length of warranty, other accepted component manufacturers and overall testing/replacement responsibility.
- D. Submit product certificates signed by manufacturers of cables, connectors, and equipment certifying that products furnished comply with requirements and warranty is valid with equipment installed.
- E. Submit evidence that all qualifications have been met.
- F. Submit make/model numbers of testers to be used for all testing of cables.
- G. Labeling Scheme: Submit labeling scheme for cabling, outlets, and equipment for approval.
 - 1. Contractor to coordinate with Owner for final room designations utilized in applied labeling scheme. Labeling schemes applied without documented Owner coordination are subject to removal and re-application by Contractor.
 - 2. All labels are to be typed.

1.5 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. As-Built Drawings: Provide a marked-up copy of original plans which reflect any changes or additions not shown on the plan. Identify all cable and jack numbering as identified on site and in System Final Test Report. Indicate routing of all IDF to MDF cabling.
- C. Submit Test Report for each basic link from patch panel to jack/patch panel. Report to include test equipment type and calibration data, date, and operator.
- D. Submit electronic copy of final comprehensive schedules for project, in software and format selected by Owner.
- E. Record actual locations of outlets and sizes of pathways.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Supplier: Authorized or Franchised distributor of specified manufacturer with minimum three years documented experience.
- C. Installer: Authorized or franchised installer of specified manufacturers with five years documented experience.
- D. Provide two references of network installation, which exceeded 200 drops and were completed within the last 12 months.
- E. Installer must be able to identify and correct non-compliance in structured cabling systems. Provide the name of a fulltime RCDD employed by the installing company.
- F. Provide satisfactory evidence of a fully equipped service organization, capable of furnishing adequate inspection and service to the system, including standard replacement parts within 50 miles of the project site.

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- G. Perform all terminations at device and headend locations using the hereby qualified installation firm.
- H. Supervise and approve all cable pulls in accordance with warranty requirements of the certifying company.

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Provide products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project site in manufacturer's original, unopened cartons and containers, each bearing names of product and manufacturer.
- B. Store products in dry spaces protected from the weather. The storage temperature shall be 68°F to 122°F.

1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of complete telecommunications horizontal cabling system for one year from Date of Substantial Completion of project at no additional cost to Owner.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. UTP Patch Cables of sufficient length to replace any similar cable installed in the project: Furnish 10 for every 100 of each type installed but not less than 10 of each type.
 - 2. Connector Modules: Furnish 10 for every 100 of each type and rating installed but not less than 10 of each type.
 - 3. Wall Plates: Furnish 10 for every 100 of each type and rating installed but not less than 10 of each type.

1.11 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 CATEGORY 6 UTP RACK MOUNT PATCH PANELS FOR DATA

- A. Manufacturers:
 - 1. Hubbell Premise Wiring
 - 2. The Siemon Company – Z-Max Series
 - 3. Systimax GigaSpeed Products – XL Series
 - 4. Leviton – 69586 Series
- B. Basis of Design – Hubbell Premise Wiring HP624/HP648 Series category 6 patch panels
- C. Design Requirements:
 - 1. Category 6 patch panels shall be standard 8-position, RJ-45 style, un-keyed, FCC and IEC 60603-7 compliant receptacle, in 24- and 48-port configurations. 96-Port will not be acceptable.
 - 2. Panel frames shall be black powder coated 14-ga steel with rolled edges top and bottom for proper stiffness.

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3. Panels shall accommodate a minimum of 24 ports for each rack mount unit (1 RMU = 1.75").
 4. Panels shall be designed for 4-pair, 100-ohm balanced unshielded twisted pair (UTP) cable.
 5. Panels shall terminate 26-22 AWG solid conductors, with maximum insulation diameter of 0.050".
 6. Panels shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.
 7. Panels shall have individual port identification numbers on the front and rear of the panel.
 8. Panels shall utilize 6-port adapter modules, each secured with one screw. Adapter module housings shall be UL 94 V-0 rated thermoplastic.
 9. Panel adapter modules shall be 110-style termination with lead free tin solder plated IDC contacts.
 10. Printed circuit boards shall be fully enclosed front and rear for physical protection.
 11. Panel contacts shall withstand a minimum of 2000 mating cycles with an FCC 8-position RJ-45 plug, without degradation of electrical or mechanical performance.
 12. Panel contacts shall be constructed of Beryllium copper for maximum spring force and durability.
 13. Panel receptacle contacts shall be arranged in-line on the PC board with pins in 1-2, 4-5, and 7-8 formed with a cross over feature to provide improved near end cross talk (NEXT).
 14. Contact plating shall be a minimum of 45 micro-inches of precious metal in the contact area over 50 micro-inch of nickel.
 15. Panel receptacle contact shall also make contact with secondary PCB to provide improved RF compensation while keeping contacts as sort as possible.
 16. IDC contacts shall be arranged in-line.
 17. Panels shall have the C6 designation, visible from the front when installed.
 18. Panels shall utilize a paired punch-down sequence to maximize electrical performance.
 19. Panel termination method shall follow the industry standard 110 IDC punch-down, using a standard 110 impact termination tool.
 20. Rear IDC contacts shall be Phosphor Bronze with 100 micro-inch lead free tin plating over nickel.
 21. HP6 series panel adapter ports shall accept optional hinged dust covers.
 22. HP6 series panel adapter ports shall accept snap-on icons for specific identification.
 23. Space above the adapter ports shall be available for additional labeling per ANSI/TIA/EIA-606-A.
 24. Category 6 panels shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.
 25. Panels shall accept a clip-on rear cable management support bar to provide cable strain relief.
 26. Panels shall include integrated label holders with white designation labels and a clear cover for each 6-port adapter.
 27. Panel adapters shall accept strain relieving stuffer caps, one cap per port.
 28. Panels shall be manufactured in the USA.
- D. Performance Requirements:
1. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
 2. Category 6 panels shall meet or exceed Category 6 transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-C.2, Transmission Performance Specifications for 4-Pair 100-ohm Category 6 Cabling.
 3. The manufacturer shall provide Category 6 component compliance certificates from third party testing organizations upon request.
 4. Panels shall be UL LISTED 1863 and CSA certified.
 5. Panels shall exceed IEEE 802.3bt DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
 6. Panel contacts shall withstand a minimum of 2000 mating cycles with an FCC 8-position RJ-45 plug, without degradation of electrical or mechanical performance.
 7. Panels shall be third party verified, error free Gigabit Ethernet performance to IEEE 802.3 standard.
 8. Category 6 panels shall exceed 4 Gb/s data transmission capacity within the bandwidth of 1 – 250 MHz when configured in a 4-connector channel.
 9. Category 6 panels shall meet or exceed the 4-connector channel performance requirements of Category 6, per the ANSI/TIA/EIA-568-C.2 standard.
 10. The 4-connector channel test configuration shall utilize Category 6 patch panels, Category 6 jack, and Category 6 patch cords, from the same manufacturer, with qualified Category 6 cable.
 11. The 4-connector channel performance margins in the table below shall be guaranteed. Conditions of requirement No. 10 above apply.
 12. Category 6 panels shall meet the current draft 10 Gb/s performance requirements of IEEE 802.3 and TSB-155, for a maximum 55-meter channel length. Conditions of requirement No. 10 above apply.

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Electrical Parameter (1 - 250MHz)	Guaranteed Margins to Category 6 / Class E Channel Specifications
Insertion Loss	3 %
NEXT	4 dB
PSNEXT	5 dB
ELFEXT	4 dB
PSELFEXT	5 dB
Return Loss	2 dB

- E. Provide patch panel port quantity as required for cables + 20% spare unless otherwise noted on the drawings.

2.2 CATEGORY 6 UTP CABLES FOR DATA

A. Manufacturers:

1. Hubbell Premise Wiring
2. The Siemon Company – 9C6P4-E3-(06)-RBA Series
3. Systemax GigaSpeed Products –2071E Series (700208093)
4. Berk-Tek, Inc. – 10032093 Series

B. Basis of Design – Hubbell Premise Wiring HC6RPB Category 6 – 550MHz Plenum

C. Design requirements

1. Cable construction shall be four twisted pairs of 23 AWG insulated solid conductors, with a ripcord, surrounded by a tight outer jacket.
2. Cable shall be manufactured with an "X"-shaped pair-divider along the center to maintain separation of individual pairs.
3. Conductor diameters shall be $0.0224" \pm .0003"$ solid copper.
4. Conductor insulation diameter shall be $0.039" \pm .0005"$ fluoro copolymer.
5. Twist lay of each pair shall vary in a manner to optimize noise immunity and minimize crosstalk.
6. Outer jacket diameter shall be $0.235" \pm .008"$ low smoke PVC, with a nominal wall thickness of 0.015".
7. Ripcord shall be directly underneath the outer jacket.
8. Cable shall be marked: "HUBBELL NEXTSPEED CATEGORY 6 Mid-Grade – AAAAAA - PLENUM - 4PR 23AWG C(UL)US CMP E255553 – VERIFIED (UL) CAT6 ANSI/TIA 568-C.2 - Z/YY (XXXX) – R#".
 - a. Frequency of marking shall be every 2.0'.
 - b. 'Z' represents the month of manufacture.
 - c. 'YY' indicates the year of manufacture.
 - d. 'XXXX' indicates the job number.
 - e. 'NNNN' indicates the sequential footage markers.
9. UL, ETL, or CSA agency certification or verification markings shall be marked on the cable jacket according to the certifying agency's requirements.
10. Color coding of the pairs shall be as follows:
 - a. Pair 1: White/Blue; Blue
 - b. Pair 2: White/Orange; Orange
 - c. Pair 3: White/Green; Green
 - d. Pair 4: White/Brown; Brown
11. Cable shall be supplied in 1000' spools.

D. Performance Requirements:

1. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
2. Cable shall exceed Category 6 transmission requirements specified in ANSI/TIA/EIA-568-C.2-1 and shall be tested through 550 MHz.
3. Cable shall exceed the requirements of TIA/TSB-155: 10 Gb/s Ethernet Operation over 55 Meters Channel Length.
4. Worst-case cable performance shall be +8.0 dB headroom over current TIA/EIA and ISO standards limits for NEXT and PSNEXT loss, and ELFEXT and PSELFEXT loss.
5. Insertion loss shall be 3.0% lower than standard Hubbell Category 6 plenum and riser cables.

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6. Worst case electrical performance characteristics shall be as follows:
 - a. Characteristic Impedance: 100 ± 15 ohms (1.0-100 MHz) 100 ± 20 ohms (101-250 MHz)
 - b. Maximum Conductor Resistance: 9.38 ohms /100 Meters @ 20°C
 - c. Maximum Resistance Unbalance: 3%
 - d. Maximum Mutual Capacitance: 5.6 nF/100 Meters @ 1 kHz
 - e. Maximum Capacitance Unbalance: 330 pF/100 Meters
 - f. Maximum Delay Skew: 35 ns/100 Meters
7. The manufacturer shall provide Category 6 component compliance certificates from third party testing organization upon request.
8. Cable shall be UL and c (UL) listed.
9. Cable shall exceed IEEE 802.3bt DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
10. Cable shall be third party verified, error free Gigabit Ethernet performance to IEEE 802.3 standard.
11. Cable shall meet or exceed the 4-connector channel performance requirements of Category 6, per the ANSI/TIA/EIA-568-C.2-1 standard.
12. The 4-connector channel test configuration shall utilize Category 6 jacks and patch panels, with Category 6 patch cords, from the same manufacturer, with qualified Category 6 cable.
13. The 4-connector channel performance margins in the table below shall be guaranteed provided the configuration satisfies requirement No. 12 above.

Electrical Parameter (1 - 250MHz)	Guaranteed Margins to Category 6 / Class E Channel Specifications
Insertion Loss	3 %
NEXT	4 dB
PSNEXT	5 dB
ACR-F	6 dB
PSACR-F	7 dB
Return Loss	4 dB

2.3 CATEGORY 6 INDOOR/OUTDOOR UTP CABLES

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systemax GigaSpeed Products
 4. Berk-Tek, Inc.
- B. Basis of Design: Hubbell Premise Wiring C6I0SPBK
- C. Usage:
 1. Slab on grade conduit runs to floorboxes or outlet boxes.
 2. Exterior conduit to handholes or other locations.
- D. Design Requirements:
 1. Cable construction shall be four twisted pairs of 23-ga insulated solid copper conductors, cabled around a cross web separator, and surrounded by an overall jacket.
 2. Cable shall be gel free and use specialty jacket materials or barriers to protect against water ingress.
 3. Jacket color shall be black, and material shall be UV resistant.
- E. Performance Requirements:
 1. Cable shall meet or exceed Category 6 transmission requirements specified in TIA-568.2D (current revision), for all electrical characteristics.
 2. Cable shall meet or exceed permanent link and 4-connector channel performance requirements specified in ANSI/TIA 568 (current revision) standard.
 3. UL Listed Type CMP
 4. Cable shall be rated for an operating temperature range of -40°F to 167°F (-40°C to 75°C)

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2.4 CATEGORY 6 UTP PATCH CABLES FOR DATA

- A. Manufacturers:
1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring HC6 Series category 6 patch cords
- C. Design Requirements:
1. Category 6 patch cords shall be constructed with a clear polycarbonate plug and boot having vertically staggered, trifurcated contacts, each having 50 micro-inches of gold plating.
 2. Plug dimensions and function shall comply with FCC 47, Part 68.5.
 3. Patch cords shall have a snag-less feature, integral to the strain relief boot on each end.
 4. Patch cords shall be constructed with category 6 patch cable, with 24 AWG 7/32 tinned copper stranded conductors, each insulated with polyethylene, and overall jacket with UL flame-retardant PVC.
 5. Patch cords shall be manufactured using a T568B wiring format and shall function suitably for either T568A or T568B wiring schemes.
 6. Patch cords shall be available in the following colors: black, blue, gray, yellow, orange, red, green, white, and purple. Custom lengths and colors shall be available with a delivery lead-time quotation.
 7. Standard patch cord lengths shall range from 3' to 20'.
 8. Category 6 patch cords shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.
- D. Performance Requirements:
1. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
 2. Category 6 patch cords shall be channel performance balanced with Hubbell category 6 jacks, patch panels, and punch-down blocks.
 3. Category 6 patch cords shall meet or exceed Category 6 component transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-C.2 standard.
 4. The manufacturer shall provide Category 6 component compliance certificates from third party testing organization upon request.
 5. Patch cords shall be cUL and UL LISTED 1863.
 6. Patch cords shall exceed IEEE 802.3bt DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
 7. Patch cords shall be third party verified, error-free Gigabit Ethernet performance to IEEE 802.3 standard.
 8. Jacks shall exceed 4 Gb/s data transmission capacity within the bandwidth of 1 – 250 MHz when configured in a 4-connector channel.
 9. Category 6 patch cords shall meet or exceed the 4-connector channel transmission performance requirements of Category 6, per ANSI/TIA/EIA-568-C.2 standard.
 10. The 4-connector channel test configuration shall utilize Category 6 patch panels, blocks, and jacks, with Category 6 patch cords, all from the same manufacturer, with qualified Category 6E cable.
 11. The 4-connector channel performance margins in the table below shall be guaranteed, provided the configuration satisfies requirement No. 10 above.
 12. Category 6 patch cords shall meet the current draft 10 Gb/s transmission performance requirements of TSB-155, provided the configuration satisfies requirement No. 9 above.

ELECTRICAL PARAMETER (1 – 250 MHZ)	GUARANTEED MARGINS TO CATEGORY 6 / CLASS E CHANNEL SPECIFICATIONS
Insertion Loss	3 %
NEXT	4 dB
PSNEXT	5 dB
ACR-F	6 dB
PSACR-F	7 dB
Return Loss	4 dB

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- E. Provide two patch cables for every connected patch panel ports. Provide length as required to terminate between fiber patch panels/outlets and equipment in a neat and workmanlike manner through cable management assemblies.

2.5 TELEPHONE CABLES

- A. Telephone Workstation Cable: Provide UTP patch cables to match those used for data.

2.6 CATEGORY 6 MODULAR JACKS

- A. Manufacturers:
 - 1. Hubbell Premise Wiring
 - 2. The Siemon Company – Z-Max Series
 - 3. Systimax GigaSpeed Products – X10 Series
 - 4. Leviton – 61110-RW6
- B. Basis of Design – Hubbell Premise Wiring HXJ6 Series category 6 jacks
- C. Design Requirements:
 - 1. Jacks shall be standard 8-position, RJ-45 style, un-keyed, FCC compliant.
 - 2. Jacks shall be designed for 4-pair, 100-ohm balanced unshielded twisted pair (UTP) cable.
 - 3. Each jack shall be single unit construction, with snap – fit to industry standard keystone opening (.760" x .580").
 - 4. Jack housings shall be high impact UL 94 V-0 rated thermoplastic.
 - 5. Jacks shall have a temperature rating of -10°C (14°F) to 70°C (158 °F).
 - 6. Jack housings shall fully encase and protect printed circuit boards and IDC fields.
 - 7. Modular jack contacts shall accept a minimum of 2000 mating cycles without degradation of electrical or mechanical performance.
 - 8. Jack contacts shall maintain a minimum deflection force of 100 grams while mated with an FCC-standard RJ-45 plug.
 - 9. Jack contacts shall be constructed of Beryllium copper for maximum spring force and durability.
 - 10. IDC contacts shall be Phosphor Bronze with 100 micro-inch tin lead 60/40 plating over nickel.
 - 11. Jacks shall terminate 26-22 AWG solid or stranded conductors.
 - 12. Jacks shall terminate insulated conductors with outside diameters up to .050".
 - 13. Jacks shall not require special cords, specialty tools or special installation requirements.
 - 14. Jacks shall be compatible with single conductor standard 110 impact termination tools.
 - 15. Jacks shall be compatible with a 4-pair single punch impact tool designed specifically for the purpose.
 - 16. Jacks shall include a translucent stuffer cap for wire retention and to permit visual inspection.
 - 17. Stuffer cap shall have retention snaps to assure conductor strain relief.
 - 18. Jacks shall accept FCC compliant 6 position plugs.
 - 19. Jacks shall accept optional hinged dust covers.
 - 20. Jacks shall be compatible with ANSI/TIA/EIA-606-A color code labeling.
 - 21. Jacks shall accept snap-on icons for specific identification.
 - 22. Jacks shall be available in various colors to meet specific customer applications.
 - 23. Jacks shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.
 - 24. Category 6 jacks shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.
- D. Performance Requirements:
 - 1. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
 - 2. Category 6 jacks shall exceed Category 6 transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-C.2, Transmission Performance Specifications for 4-Pair 100-ohm Category 6 Cabling.
 - 3. Category 6 jacks shall exceed 10 Gb/s transmission requirements for connecting hardware, under the constraints of ANSI/TIA-TSB-155 (current draft).
 - 4. The manufacturer shall provide Category 6 component compliance certificates from third party testing organization upon request.
 - 5. Jacks shall be UL LISTED 1863 and CSA certified.

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6. Jacks shall exceed IEEE 802.3bt DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
7. Jacks shall be third party verified, error free Gigabit Ethernet performance to IEEE 802.3 standard.
8. Jacks shall exceed 4 Gb/s data transmission capacity within the bandwidth of 1 – 250 MHz when configured in a 4-connector channel.
9. Jacks shall exceed the 4-connector channel performance requirements of Category 6, per the ANSI/TIA/EIA-568-C.2 standard.
10. Jacks shall exceed the 4-connector Category channel performance requirements for 10 Gb/s transmission over Category 6, according to TIA/TSB-155 (current draft).
11. The 4-connector channel test configuration shall utilize Category 6 patch panels and Category 6 patch cords, from the same manufacturer, with qualified Category 6E cable.
12. The 4-connector Category 6 channel performance margins in the table below shall be guaranteed, provided the configuration satisfies requirement No. 11 above.

Electrical Parameter (1 - 250MHz)	Guaranteed Margins to Category 6 / Class E Channel Specifications
Insertion Loss	3 %
NEXT	4 dB
PSNEXT	5 dB
ACR-F	6 dB
PSACR-F	7 dB
Return Loss	4 dB

2.7 STAINLESS STEEL FACE PLATES AND UNLOADED MODULES

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring IMSS Series Modular Faceplates and Modules.
- C. Design Requirements:
 1. IMSS Series Faceplates:
 - a. Faceplates shall be constructed of Stainless Steel.
 - b. Faceplates shall be 2.75" W x 4.5" H for single gang and 4.5" X 4.5" for double gang.
 - c. Faceplates shall accept modules loaded with Hubbell HXJ-series series jacks and Hubbell Snap-Fit fiber optic, audio, and video connectors for multimedia applications.
 - d. Two #6-32 pan head Phillips/slotted mounting screws shall be included with each single gang faceplate.
 - e. Four #6-32 pan head Phillips/slotted mounting screws shall be included with each double gang faceplate.
 - f. Faceplates shall be compatible with standard NEMA openings and boxes.
 - g. Faceplates shall be compatible with raceway fittings, surface mount boxes, service fittings, service poles, flush mount boxes and drywall rings.
 2. IMSS Series Modules:
 - a. Faceplate Modules shall be constructed of high impact, UL94 V-0 rated thermoplastic.
 - b. Modules shall be compatible with IMSS Series Faceplates, raceway, floor boxes, poke throughs, surface mount boxes, patch panels, furniture plates, and service poles.
 - c. Modules shall snap firmly into front of faceplate and position flush to outer plate surface for field installation in any of the specified mounting hardware devices and media configurations.
 - d. Single gang IMSS Series Faceplate shall accept (3) 1U modules
 - e. Double Gang IMSS Series Faceplate shall accept (6) 1U modules.
 - f. 1 Unit Modules shall be available for 1- and 2-Port Keystones, Blanks, and punched blanks to support the following connections per work area requirements.
 - 1) RJ-45 Category 6 jack per ANSI/TIA/EIA-568-C.2
 - 2) RJ-45 Category 6A jack per ANSI/TIA/EIA-568-C.2

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- 3) ST fiber optic connector per EIA/TIA-604-3
- 4) SC fiber optic connector per EIA/TIA-604-3
- 5) LC fiber optic connector per EIA/TIA-604-3
- 6) S-Video Gold Jack
- 7) RCA Gold Jack (color coded)
- 8) BNC connector (straight mount)
- 9) Gold F connector (straight mount)
- 10) SVGA (female)
- 11) 3.5 Mini Stereo Jack
- 12) Gold Speaker Post
- 13) HDMI connector
- 14) USB connector
- 15) Blank filler plate

2.8 CATEGORY 6 PLENUM SURFACE MOUNT BOX 2-PORT

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring HSB2EIP (Plenum Rated) with HXJ6 Series category 6 jacks
- C. Application – Wireless Access Points, IP cameras and other remote IP devices.
- D. Design Requirements:
 1. Box material shall be constructed from high impact thermoplastic; UL 94-V0.
 2. Box shall be suitable for use in other environmental air space in accordance with Section 300.22 of the National Electric Code.
 3. Box shall be tested for UL 2043.
 4. Box shall meet the requirements of UL 1863 modules and frames.
 5. Box shall be RoHS compliant.
- E. Performance Requirements:
 1. Box shall be suitable for air handling spaces.
 2. Box shall have a low-profile design.
 3. Box shall accept Hubbell HJ and HXJ jacks and audio/video keystone connectors.
 4. Box shall have easy cover latches to provide flexibility for simple moves, adds and changes.
 5. Box shall have a secure, tamper resistant screw.

2.9 FIELD-TERMINATED PLUG, CATEGORY 6

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring SP6 or SP690 (Right Angled)
- C. Application – Wireless Access Points, IP cameras and other remote IP devices.
- D. Design Requirements:
 1. The plug shall meet the following criteria:
 2. Meet or exceed all requirements for Category 6 as described in ANSI/TIA-568-C.2.
 3. Compliant with ANSI/TIA-1096-A.
 4. Accommodate T568A/B wiring schemes.

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5. Accommodate 26-22 AWG shielded or unshielded, solid or stranded conductors.
6. Support Power over Ethernet (PoE) up to 100 watts.
7. Connector body constructed of die-cast zinc
8. Suitable for plenum areas.
9. UL listed.

2.10 CATEGORY 6 CORD REEL

- A. Hubbell Model HBL150CAT6:
 1. Provides Ethernet communications with very low electrical noise for unparalleled performance.
 2. 4 ft Input Pigtail
 3. 1000BaseT (Gigabyte Ethernet) Compatible
 4. Plug and Play Ethernet Connection
 5. RJ45 Plugs on both Input and Output Ends
 6. Ratchet locking mechanism and Ball Stop
 7. 50' of cable
 8. Provide all required mounting accessories
 9. Provide data outlet mounted on ceiling for cord reel.
- B. Color – Yellow

2.11 STAINLESS STEEL WALL-MOUNT PHONE PLATE

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring SP6R
- C. Listings:
 1. UL and cUL Listed 1863
 2. ANSI/TIA/EIA-568-C.2 Category 6 component
 3. ISO 11801/60603-7-41 Category 6 component
 4. Mechanical: Verified to TIA-568-C.2
 5. Mechanical TIA-568-C.2
 6. RoHS Compliant
- D. Design Requirements:
 1. Nose Contact: Beryllium copper with precious metal plating with nickel under-plating.
 2. IDC Contact: Phosphor bronze with 100 micro-inch tin lead 60/40 plating over nickel under plating.
 3. Jack Housing: High-impact thermoplastic (UL 94V-0)
 4. Stuffer Cap: Lexan® (UL 94 V-0)
- E. Performance Requirements:
 1. Electrical:
 - a. Center balanced to Category 6 plug specifications
 - b. Positive PSACR beyond 300 MHz (channel)
 - c. 4+Gbs capacity within the bandwidth of 1-250MHz (channel)
 - d. Qualified to 150% of 802.3bt PoE Current Level
 2. General Information:
 - a. Backward compatible to lower installed Categories
 - b. 100% factory tested
 3. Mechanical:
 - a. Nose Contact Mating Cycles: 2000
 - b. IDC Contact Termination: 10x
 - c. Keystone Latching Force: 25 lbs.

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2.12 CABLE LABELS

- A. Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

2.13 OUTLET PLATE & PATCH PANEL LABELS

- A. Preprinted, flexible, self-adhesive vinyl with legend over-laminated with a clear weather and commercial resistant coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install all cables in accordance with equipment manufacturer's instructions, and with recognized industry practices, to ensure the installation complies with requirements of the NEC, ANSI/TIA/EIA-568-C.1 Commercial Building Telecommunications Cabling Standard and BICSI'S "Telecommunication Distribution Methods Manual" (current edition).
- B. Install all cables only when the temperature is between 32°F to 122°F.
- C. Wiring Method: Wiring shall be installed in EMT conduit within walls and above inaccessible ceilings. Wiring shall be installed in cable tray where it is present. Wiring installed above accessible ceilings between ceiling mounted devices or conduit stub-ups and the cable tray shall be exposed and supported by J-hooks, spaced a maximum of 5'-0" on center, with minimum 1" flat bearing surface. Provide conduit sleeves, bushings and fireproofing through all wall penetrations. All wiring not in EMT conduit shall be kept a minimum of 6" away from all lighting fixtures, motors, and transformers. Cables cannot be ty-wrapped or stapled to ceiling or structural supports, conduit, or other items.
- D. Test each cable as detailed in specification. Include patch cord in test channel.
- E. Identify all cables with a neatly typed label as detailed in specification.
- F. Provide horizontal and vertical cable management in all racks, on all backboards and any other location cabling is not routed in conduit or cable tray. Size cable management for 50% additional cables.
- G. UTP Cable Length:
 - 1. Maximum installed length of each UTP cable between closet and workstation outlet is to be 90 meters (295'). Ensure lengths are within specification prior to installation. Contact Engineer for procedure in the event of excessive distances prior to installation.
 - 2. Minimum length shall be 15 meters (49'). Provide service loop as required to increase length on short runs.
- H. Install cable without damaging conductors, shield or jacket, do not use unjacketed pairs for jumpers.
- I. Do not bend cable in handling or in installing to smaller radii than minimums recommended by manufacturer.
- J. No splicing is permitted for UTP cables. Cables must be continuous between termination points. Make splices, taps and terminations only at indicated outlets, terminals, cross-connect and patch panels.

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- K. Provide at least 10' of cable slack at MDF or IDF closet. This slack may be stored in the cable tray or a cable management device behind the MDF/IDF.
- L. Provide 2' diameter in service loops or use figure-8 or serpentine.
- M. Provide at least 1' of slack at each workstation outlet. This slack may be coiled within device box observing bend radius minimum or within accessible ceiling space using approved J-hook support.
- N. Remove jacket of cable and untwist individual UTP conductors the minimum amounts required to terminate on jacks and patch panels.
- O. Category 6 cable fill in conduit is 40% maximum as follows:
 - 1. 3/4" - 4 UTP Cables
 - 2. 1" - 6 UTP Cables
 - 3. 1-1/4" - 12 UTP Cables
 - 4. 1-1/2" - 16 UTP Cables
 - 5. 2" - 22 UTP Cables
 - 6. 2-1/2" - 36 UTP Cables
 - 7. 3" - 50 UTP Cables
 - 8. 3-1/2" - Not recommended
 - 9. 4" - Not recommended
 - 10. Provide larger conduits than recommended for cable fill if indicated on the Drawings.
- P. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 - 1. Pull cables simultaneously if more than one is being installed in the same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway.
- Q. Secure and support cable at intervals not exceeding 5'-0" and not more than 1'-0" from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- R. Wiring within IDF/MDF and Enclosures: Provide adequate length of conductors. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- S. Separation of Wires: Comply with EIA/TIA-569 rules for separating unshielded copper telecommunications equipment cables from potential EMI sources, including electrical power lines and equipment.
- T. Support raceways, cabinets, and all other equipment in accordance with manufacturer's instructions.

3.3 LABELING

- A. System: Use a unique, 3 syllable alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
 - 1. First syllable identifies and locates wiring closet or equipment room where cable originates.
 - 2. Second syllable identifies and locates cross-connect or patch-panel field in which cable terminates.
 - 3. Third syllable designates type of media (copper or fiber) and position occupied by cable pairs or fibers in the field.
 - 4. Example: A2-2-C46
- B. Workstation: Label cables within outlet boxes.
- C. Within Connector Fields, in IDF/MDF Rooms and Consolidation Points: Label each connector and each discrete unit of cable terminating and connecting hardware. Where similar jacks and plugs are used for both communication and data-processing equipment, use a different color for jacks and plugs of each service.

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- D. Cables, General: Label each cable within 4" of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
- E. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 100 feet.
- F. Cable Schedule: Post in prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Provide electronic copy of final comprehensive schedules for project, in software and format selected by Owner.

3.4 GROUNDING

- A. Comply with Section 260526 and applicable details on plans.
- B. Provide connections to the main ground bus on all backboards, telephone line protectors, IDF Racks and MDF Racks in the project. Connect to ground buses with cables per Specification Section 260526 and applicable details on plans.

3.5 FINAL TESTING AND INSPECTION

- A. Provide testing in accordance with ANSI/TIA/EIA-568-C.1.
- B. Cable Test: Provide prior to substantial completion, a Performance Evaluation Report, which will contain the following:
 - 1. Cable Test: List by cable number each UTP Cable in the project, which details:
 - a. UTP Cables:
 - 1) Cable ID Number
 - 2) List continuity, reversal, open, shorts and miswires
 - 3) Category performance
 - 4) List other discrepancies with the UTP installation (bad terminations, faulty labeling, etc).
 - 5) Tester printout for each cable.
 - 2. UTP Cable Testing: Test each cable pair of each cable after installation for Specified Category performance. Conduct test with a tester designed for testing above cable (with RJ-45 jacks installed) from each data outlet to associated patch cord through +0 panel jack (Channel). Provide printout for each test as part of the Performance Evaluation Report. Minimum performance categories for report are to be as follows:
 - a. Wire Map/Continuity
 - b. Length
 - c. Near End Crosstalk (pair to pair) NEXT
 - d. Near End Crosstalk (power sum) PSNEXT
 - e. Equal Level Far-End Crosstalk Loss (pair to pair) ELFEXT
 - f. Equal Level Far-End Crosstalk Loss (power sum) PSELFEXT
 - g. Return Loss
 - h. Attenuation
 - i. Propagation Delay
 - j. Delay Skew
 - k. PSACR (Powersum Attenuation – Crosstalk Ratio)
 - 3. System Performance Report: Provide a narrative detailing the system as a whole, in regard to the quality of installation and any discrepancies affecting performance. This narrative to indicate a summary of the above Cable Test, as well as an accurate summary of specified Category performance as well as capability of the cabling system to perform at specified Category bandwidth.

3.6 WARRANTY

- A. The installation shall be provided with a minimum 25-year warranty for strict compliance with the performance requirements of ANSI/TIA/EIA-568-C.1 to support and conform to ANSI/TIA/EIA-568-C.1 specifications covering any current or future application which supports transmission over a properly constructed horizontal

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cabling system premises network which meets the channel performance as described in ANSI/TIA/EIA-568-C.2.

END OF SECTION 271500

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SECTION 277000 – LOCAL AUDIO/VISUAL REINFORCEMENT SYSTEM ROUGH-INS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit
- B. Boxes

1.2 SYSTEM REQUIREMENTS

- A. Provide service entrance conduits as shown on the plans.
- B. Provide a complete raceway system for future cabling installed under a separate contract. Include the following:
 - 1. Wall Boxes
 - 2. Conduits between boxes and Audio-Visual (AV) equipment racks

1.3 COORDINATION

- A. Coordinate work of this section with all cables provided under another contract.
- B. Adjust arrangements and locations of backboxes and conduits to accommodate and optimize arrangement and space requirements. Review revised layouts with Engineer before proceeding with work.

1.4 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCT

2.1 CONDUIT

- A. Provide all conduit required by the project conditions.
- B. Provide conduit bushings on all conduit.

2.2 BOXES

- A. Provide all boxes required by the project conditions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide firestopping to raceway penetrations of the fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7.
- B. Provide pull strings in all unused conduits for cabling installation under a separate contract.

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END OF SECTION 277000

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SECTION 280500 – COMMON WORK REQUIRED FOR ELECTRONIC SAFETY & SECURITY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire Rated Pathways
- B. Hangers and Supports
- C. Conduits and Backboxes

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code

1.3 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section
 - b. A list of all equipment to be provided and installed.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. As-Built Drawings: Provide a marked-up copy of original plans which reflect any changes or additions not shown on the plan.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Provide products listed and classified by Underwriters Laboratories, Inc., or a testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project site in manufacturer's original, unopened cartons and containers, each bearing names of product and manufacturer.
- B. Store products in dry spaces protected from the weather. The storage temperature shall be 68°F to 122°F.

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1.8 PLENUM WIRING

- A. This is an air "Plenum" project. Cabling installed in plenums or in areas above hung ceilings, used as a plenum, shall be plenum rated or installed in conduit.

1.9 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 FIRE RATED PATHWAYS

- A. Manufacturers:
 - 1. Specified Technologies Inc.
 - a. EZ-PATH Fire Rated Pathway (single, double, and triple)
- B. Pathways:
 - 1. Cables passing through fire-rated floors or walls shall pass through fire-rated wiring devices which contain an intumescent insert material that adjusts automatically to cable additions or subtractions.
 - 2. The device shall have an F rating equal to the rating of the barrier in which the device is installed.
 - 3. Wiring devices shall be capable of allowing a 0 to 100% visual fill of cables.
 - 4. Wire devices shall be of a sufficient size to accommodate the quantity and size of electrical wires and data cables required.
 - 5. Wire devices to be provided with steel wall plates allowing for single or multiple devices to be ganged together.

2.2 FIRESTOPPING

- A. The Contractor shall be responsible for providing permanent, UL approved firestopping systems for all penetrations through fire rated floor or fire rated wall assemblies. For areas that will require future access for the installation of additional cables, repair, or retrofit, the firestopping system shall consist of re-usable intumescent pillows or putty.
- B. Subject to compliance with project requirements, firestopping materials may be provided by one of the following manufacturers:
 - 1. Specified Technologies Inc., (STI) Somerville, NJ (800) 992-1180
 - 2. Tremco, Beechwood, OH (800) 321-7906
 - 3. 3M, St. Paul, MN (800) 328-1687
 - 4. Hilti, Tulsa, OK (800) 879-8000
- C. Submit the following for review and approval:
 - 1. Product data sheets
 - 2. UL System drawings for each firestopping application
 - 3. Manufacturer's Certificates of Conformance for their products

2.3 HANGERS AND SUPPORTS

- A. Non-continuous cable supports (J-hooks):
 - 1. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables.
 - 2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
 - 3. Non-continuous cable supports 1-15/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger.
 - 4. Non-continuous cable supports shall have an electro-galvanized finish and be rated for indoor use in non-corrosive environments.

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- 5. Non-continuous cable supports shall be UL listed, with manufacturer's name and part number stamped on.

- B. Wire Rod Type Cable Tray: Refer to Section 260536 for wire rod type cable tray.

2.4 CONDUITS AND BACKBOXES

- A. Refer to Section 260533 for raceways and boxes.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS

- A. Verify locations and mounting heights with the electronic safety & security equipment.

3.2 FIRESTOPPING

- A. Penetrations in fire rated partitions shall be sealed to maintain the fire integrity of the assembly. Provide fire stopping meeting the same rating as the assembly being sealed.
- B. All firestopping shall meet the requirements of ASTM E-814 and UL 1479.
- C. Comply with all installation requirements of Division 7.

3.3 HANGERS AND SUPPORTS INSTALLATION

- A. Provide supports as required to support all cabling.
- B. Provide cable tray as required to support all cabling.
- C. Comply with all installation requirements of Sections 260529 and 260536.

3.4 CONDUITS AND BACKBOXES INSTALLATION

- A. Provide raceways and boxes as required for cabling.
- B. Comply with all installation requirements of Section 260533.
- C. The minimum conduit size for conduit pathways and stub-outs shall be 3/4 inch.

3.5 SLEEVE INSTALLATION FOR PENETRATIONS

- A. Penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.

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- F. Extend sleeves installed in floors 2" above finished floor level.
- G. Size pipe sleeves to provide 1/4" annular clear space between sleeve and pathway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants".
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
- K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1" annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 SYSTEM WIRING METHODS

- A. Provide pathways as required in accordance with the following paragraphs. Where wiring is required by other specification sections, provide communications wiring in accordance with the following paragraphs.
 - 1. Wire Routing: Route all device wiring from each device up into accessible ceiling cavity within metallic conduit in recessed or unfinished areas and within surface raceway for renovated non-fishable areas. Stub all conduits into accessible ceiling cavity and provide bushing for each.
 - 2. Cable Routing: Route cable for all device wiring within accessible ceiling cavities. Install cable supports at 4' spacing maximum or in cable tray where applicable. No cabling is to lie on or attach to ceiling tile, ducts, pipes, conduits or ceiling suspension wires, rods, or structural members. Provide conduit stubs from devices and panels to the ceiling cavities. Use cable tray for support when it is shown on the drawings.
 - 3. Route all system wiring from system equipment within metallic conduit up into nearby ceiling cavity and connect to the wiring system indicated in 1 and 2 above. Provide bushings at conduit ends.
 - 4. Provide raceways for cabling in all open structure ceiling spaces.
 - 5. Refer to individual sections for methods specific to that system.

3.8 CEILING TILE REMOVAL

- A. The Contractor shall remove and replace ceiling tile and grid work as required for the installation of communications cabling. Damaged tile and grid shall be replaced by the Contractor and shall match the existing ceiling system.

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END OF SECTION 280500

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SECTION 28 10 00 – ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Electronic access control system components, including:
 - a. Access control
 - b. Security:
 - 1) Threat Level Management
 - 2) Time Zones controlled with Linking Logic
 - 3) Virtual Outputs
 - 4) Point Monitoring
 - 5) Photo ID Badging
 - 6) Guard Tour
 - 7) Time and Attendance
 - 8) Key Tracking
 - 9) Image Recall with Historic and User Accountability Reporting
 - 10) Live CCTV display/control
 - 11) Interface with CCTV and Central Station Automated Alarm Systems
 - 12) Digital Video Recorder Integration
- B. Related Sections:
 - 1. Division 28 16 00 – Intrusion Detection

1.3 SYSTEM OVERVIEW

- A. PC based: The system is a PC based Building/Facility Management and Monitoring System used to control and monitor personnel and alarm activity. The DSX system provides 5 different controllers that offer various configurations of card reader inputs, relay outputs and alarm inputs. These controllers can be combined to provide the exact number of inputs and outputs required for each application. DSX controllers use fully distributed database architecture with real-time processing performed at each controller.
- B. Distributed Processing: This fully distributed processing provides that all information (time, date, valid codes, access levels, etc) is downloaded to the controllers so that each controller makes its own access control decisions. There are no hierarchical or intermediate processors to make decisions for the controllers. Also, the PC is not required to make any decisions for the controllers including any global functions. This provides Instant response to card reads regardless of system size. This also provides for no degradation of system performance in the event of communication loss to the host (or actual loss of host). All time zones, access levels, linking events, holiday schedules, and global functions remain operational. Upon communication loss to the host all controllers shall automatically buffer event transactions until the host communications is restored, at which time the buffered events will be automatically uploaded to the host. The system maintains full feature capability regardless of the style of the communications from the PC. This means that DSX dial-up modem sites can utilize all standard features like linking between controllers without the PC needing to be online.
- C. System Size: The system is designed to support up to 32,000 separate Locations using a single PC with combinations of direct connect, dial-up or TCP/IP LAN connections to each Location. DSX defines a loop of up to 64 controllers as one Location. Each Location has its own database and history at the host PC.

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Locations may be combined to share a common database and create a very large network of controllers. Each Location can have up to 128 devices.

- D. Intelligent Controllers: Each DSX controller is an Intelligent Control Unit. The first controller of every Location is designated as the "Master". All subsequent controllers at the same Location are designated as "Slaves". Any DSX controller may be selected by dipswitch settings to work as the Master controller. The Master controller performs all the same functions as a Slave controller, but it is also responsible for polling all Slave controllers and communicating with the host PC. The Master controller does not make any access decisions for the Slave controllers. It is simply the messenger for information from the controllers to the PC and for information from the PC to the controllers.
- E. Controller operating system resides in Flash ROM on each controller. It is upgradeable thru a download from the Host PC to each of the 1040 Series and 1022 controllers in the system. Upgrades in controller operating system shall NOT require PROM changes.
- F. Processing Power: Each intelligent controller uses an Intel microprocessor (same as a PC) as its engine. In a large system, the total processing may approach, or even exceed that of a Mini Computer. Instead of all the processing power being centralized in one "Mini" it is distributed throughout the system.

1.4 SYSTEM REQUIREMENTS

- A. Software Requirements:
 - 1. WinDSX is compatible with XP Pro Svc Pack 2, Windows Vista Business Svc Pack 1, Windows 7 Pro 32/64 bit, Windows 8 Pro 32/64 bit. Server platforms include Server 2000, 2003, 2008, and 2008 R2.
 - 2. WinDSX-SQL program utilizes Microsoft SQL Server 2005 Svc Pack 3 /2008™
 - 3. 2008 R2, and SQL 2012 for database deployment and management.
 - 4. Multi-user and multi-tasking capability allowing for independent activities and monitoring to occur simultaneously at different Workstation PCs.
 - 5. Utilize graphical user interface with simple pull-down menus and a menu tree format that conform to interface guidelines defined by Microsoft Corporation.
 - 6. Allow for language localization.
 - 7. Allow LAN/WAN network applications, using TCP/IP protocol, with up to 1000 Workstation PCs.
 - 8. System shall be site licensed, not seat licensed.
 - 9. System shall have open architecture that allows importing and exporting of data and ability to interface with other systems.
 - 10. Operator Identification logon password protected.
- B. Hardware Requirements:
 - 1. Comm Server PC: Windows XP Pro, Vista Business, Windows 7 Pro, or Windows 8 Pro - PC with a 2.8 GHz Pentium processor / 2GB RAM (minimum) or greater depending on system scope. Server 2003, and 2008/R2 will work but not required.
 - 2. Workstation PC: Windows XP Pro, Vista Business, Windows 7, Windows 8 Professional PC with a 2.8 GHz Pentium processor / 2GB RAM (minimum) or greater depending on system scope.
 - 3. Other requirements as indicated herein.

1.5 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Minimum of 10 years experienced in providing security access control components for projects of similar nature and complexity.
 - 2. Maintain a 24-hour toll free telephone assistance line for installing dealer support.
- B. Installer:
 - 1. Minimum of 5 years' experience in performing work of this section who has specialized in the installation of work similar to that required for this project.
 - 2. Have at least one technician trained by the manufacturer.
 - 3. Maintain adequate supply of replacement parts for system components provided.

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- C. Regulatory Requirements: Installed products shall meet standards of a recognized testing laboratory (UL or comparable).

1.6 SUBMITTALS

- A. Submit in accordance with requirements of Section 01 33 00.
- B. Shop Drawings: Detailing all connected devices, of sufficient detail to adequately communicate that recommended software meets access system requirements, including:
 - 1. System device locations on architectural floor plans.
 - 2. Full schematic wiring information for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at devices.
 - 3. A complete access control system one-line block diagram.
 - 4. System sequence operation description.
- C. Product Data:
 - 1. Manufacturer's data for all material and equipment, including terminal devices, local processors, computer equipment, access cards, and any other equipment required for the complete access management and alarm monitoring system.
 - 2. System description, including analysis and calculations used in sizing equipment, and also indicating how equipment will operate as a system to meet the performance requirements of the access control and alarm monitoring system.
 - 3. A description of the operating system and application software.
- D. Contract Close-out Submittals:
 - 1. Operating instructions.
 - 2. Recommended maintenance required and maintenance intervals.
 - 3. Parts list, including wiring and connection diagrams.
 - 4. Record Documents: Maintained on a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the access control and alarm monitoring system, accurately reflecting all changes and additions to the access control and alarm monitoring system.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Section 01 60 00.
 - 1. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
 - 2. Store materials protected from exposure to harmful environmental conditions and at temperature conditions recommended by manufacturer.
 - 3. Handle products and systems in accordance with manufacturer's instructions.

1.8 WARRANTY

- A. Project Warranty: Comply with requirements of Section 01 78 36.
- B. Manufacturer's Warranty: Submit manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRONIC ACCESS CONTROL

- A. Manufacturer:
 - 1. DSX Access Systems, Inc.
10731 Rockwall Road

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Dallas, Texas 75238
(214) 553-6140 voice
(214) 553-6147 facsimile
(800) 346-5288 voice

- B. Local Authorized Distributor:
1. Electronic Systems Installers, Inc.
56 N. Queen St.
York, PA 17403
Mark Nardontonia: 717-843-9955; mark@securityesi.com

2.2 SERVER or WORKSTATION CONFIGURATION

- A. 100% IBM compatible PC approved by Microsoft Corporation for running the Microsoft Windows Windows XP Pro, Vista Business, Windows 7 Pro, or Windows 8 Pro - PC with a 2.8 GHz Pentium processor / 2GB RAM (minimum) or greater depending on system scope. Server 2003, and 2008/R2 will work but not required.
- B. Processors:
1. Pentium 2.8 GHz / 2GB RAM (minimum) Host PC single PC, single Location system, or LAN Workstation for single Location system.
 2. Pentium 3.3 GHz / 2GB RAM (minimum) for LAN Comm. Server or File Server for single Location.
 3. Pentium 3.3 GHz / 4GB RAM (minimum) for LAN Comm. Server and/or combination File Server for multiple Location system.
- C. Operating System: XP Pro Svc Pack 2, Windows Vista Business Svc Pack 1, Windows 7 Pro 32/64 bit, Windows 8 Pro 32/64 bit. Server platforms include Server 2000, 2003, 2008, and 2008 R2.
- D. Hard Disk: 1 Gigabyte free space.
- E. Drives: 16x CD-ROM drive or higher.
- F. Sound Card: Windows compatible; required for sound operations; not required for system operation.
- G. Super VGA monitor, 800 x 600 pixels minimum resolution; 17-inch or larger recommended.
- H. Backup Device: Windows Compatible backup gear.
- I. Peripherals:
1. Serial Ports: Minimum of 1 for either direct or dial-up modem communications.
 2. Mouse: Microsoft IntelliMouse or equivalent recommended but not required.
 3. Modem: DSX provided external dial-up modem only.
- J. LAN:
1. Adapter Card: Required for LAN applications only. 100Mbit is optimum.
 2. If no LAN is required, an MS Loopback Adapter shall be used.
- K. Printer: All Windows XP Pro / Vista Business / Windows 7 /Windows 8 - supported printers; required for transaction hard copy. Not required for system operation.

2.3 SOFTWARE

- A. Software: WinDSX-SQL Software, complete with the following features and functions:
1. Access control and alarm monitoring system that conforms to the programming and interface guidelines defined by Microsoft Corporation for XP Pro Svc Pack 2, Windows Vista Business Svc Pack 1, Windows 7 Pro 32/64 bit, Windows 8 Pro 32/64 bit, Windows 2003/2008/2008 R2 Server or Microsoft SQL Server 2005/2008/2008 R2 or 2012 compatible software.
 2. Basic Functions:
 - a. Access Control

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- b. Activity Monitoring
 - c. Database Management
 - d. Database Reporting
 - e. Point status and overrides.
3. System Capacities:
- a. Support a minimum of 32,000 Locations having grouping capabilities to share cardholder databases between sites.
 - b. Support a minimum of 4,096,000 readers or 128 reader-controlled doors per Location.
 - c. Support a minimum of 170 different card reader formats.
 - d. Support 1.6-billion cardholders total or up to 50,000 access codes/cards per Location.
 - e. Support a minimum of 32,000 supervised alarm inputs or a minimum of 2048 per Location.
 - f. Support a minimum of 32,000 programmable outputs or a minimum of 2048 per Location.
 - g. Support up to 32,000 facility codes (site codes) total or a minimum of 2048 per Location.
 - h. Support a minimum of 32,000 time zones or a minimum of 2048 per Location with each time zone having 3 holiday overrides.
 - i. Support a minimum of 32,000 companies/card holder groups.
 - j. Support a minimum of 32,000 self-purging/auto-renewing holidays.
 - k. Support a minimum of 99 user defined fields per Location.
 - l. Support a minimum of 32,000 system operators.
 - m. Support a minimum of 32,000 password profiles to determine accessibility of system functions for each operator.
 - n. Support a minimum of 999 operator comments.
 - o. Support a minimum of 32,000 graphic alarm maps for full input, output, CCTV control, DVR control, and alarm handling.
 - p. Support a minimum import of 21 graphic file types for maps.
 - q. Support a minimum of 32,000 custom action messages per Location to instruct operator on action required when alarm is received.
 - r. Support a minimum of 32,000 ASCII output messages per Location for use to interface with CCTV and pager systems.
 - s. Support a minimum of 32,000 input to output links.
 - t. Support a minimum of 32,000 code to output links.
 - u. Support a minimum of 999 guard tours.
 - v. Each controlled entry/exit shall have the ability to be locked (secured) and unlocked (open) up to 4 times a day through time zone programming.
 - w. Each monitored input shall have the ability to be armed and disarmed up to 4 times a day through time zone programming.
 - x. Each reader/keypad shall have the ability to be enabled/disabled up to 2 times a day through time zone programming.
 - y. Each card/code shall have the ability to be enabled/disabled up to 4 times per day per entry point through access level programming.
 - z. Provide for support up to 9999 cameras displayed per workstation with live video and Pan, Tilt, Zoom, Scan and Auxiliary controls in video window.
 - aa. Support a minimum of 32,000 Access Levels.
 - bb. Support a minimum of 4 Anti-Passback zones per Location.
4. Basic System Features: These features are considered to be standard without the need for any add-on software or hardware.
- a. Shall have up to 1000 Workstations with one site license.
 - b. Shall have the ability for the main Communications engine portion of the software, or CS.EXE, to run as a service, eliminating the need for an OS logon.
 - c. Shall have built in prevention for multiple comm servers running at the same time when the software is setup incorrectly.
 - d. Each workstation shall have access to all features if password profile allows. In addition, if workstation is used for other tasks (applications) system has option of having an Alarm Pop-up window appear to alert of pending alarms while the operator is using some other program.
 - e. Password profiles shall be individually customized to allow or disallow operator access to any program function for each Location.
 - f. Workstation Event Filtering: Shall allow user to define events and alarms that will be displayed at each workstation. Each workstation shall be able to define and assign time zone-controlled filters. In addition, if an alarm is unacknowledged (not handled by another workstation) for a preset amount of time the alarm will automatically appear on the filtered workstation.
 - g. Shall have the ability to sort the location tree by name in Workstation.

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- h. Stackable Device Types: Shall allow for a different Wiegand Device Type to be assigned to each Device and all Devices within the same Location sharing the various formats between them.
- i. Threat Level Management: With a click of a mouse, press of a button, or presentation of a Card, the system shall be instantly reconfigured to coincide with the Homeland Security Advisory System and meet any heightened security requirements.
- j. CCTV Alarm Interface: Shall allow commands to be sent to CCTV systems during alarms (or input change of state) thru serial ports.
- k. Animated Response Graphics: Provide for highlighting Alarms with flashing Icons on graphic maps. The current status of alarm inputs and outputs shall be displayed and constantly updated to display changes in real time through animated Icons.
- l. Provide the ability to view and control cameras from the graphic maps.
- m. Multimedia Alarm Annunciation: Provide for WAV files to be associated with alarm events for audio annunciation or instructions.
- n. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, and/or option of requiring the operator to enter a comment about disposition of alarm.
- o. Provide 99 User Defined Fields for cardholder data. System shall have the ability to run searches and reports off of any combination of these fields. Each UDF can be configured with any combination of the following features. MASK: Determines a specific format that data must comply with. REQUIRED: Operator is required to enter data into field before saving. UNIQUE: Data entered must be unique. DE-ACTIVATE DATE: Data entered will be evaluated as an additional de-activate date for all cards assigned to this cardholder. NAME ID: Data entered will be considered a unique id for the cardholder. AUTO INCREMENTING CARD NUMBER: Badge serial number that prompts the operator to increment the number each time the badge is printed. UDF DATA IS HIDDEN: The system shall also provide the ability to restrict the viewing of certain UDFs containing sensitive information on a field-by-field basis. SELECT DATA FROM LIST: This allows data to be predefined and lets the user pick one of the selections from a drop-down list. The choices and the order in which they are viewed can be predefined. EMAIL ADDRESS: Select this if the entries in this field are Email Addresses. There must be an Email Address – User Defined Field for the implementation of Email Groups and Email Alarm Notification. Any Card Holder to be in an Email Group to receive alarm notifications must have their Email Address defined in this UDF. This must be the full and proper Email Address (no aliases allowed).
- p. Time and Attendance reporting shall be provided to match in/out reads and display cumulative time in for each day and cumulative time in for length of the report.
- q. Guard Tour: Shall provide ability to Plan, Track and Route tours. Shall produce alarm during tour if guard fails to make a station. Tours can be programmed for sequential or random tour station order.
- r. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
- s. Floor Select Elevator Control and Reporting: Provide for any Card read to activate any floor from the appropriate Cab and report what floor was selected by which cardholder.
- t. After Hours HVAC control: Provide for any Card read to activate or control individual HVAC zones based on access and linking level.
- u. A means for importing of custom Icons for representation of Inputs, Outputs, or Cameras shall be provided.
- v. Photo ID Badging: Provide ability to import images from bitmap file formats, digital cameras, TWAIN cameras, scanners, or live video. Allows image cropping and editing, WYSIWYG badge building application, and full badge printing/print preview capabilities.
- w. Photo Recall on Card Use: Provide means that Images can be automatically displayed on a workstation in response to any card read on any reader, as dictated by Time zone per card reader.
- x. Photo Recall on Event Selection: Provide means that Images can be manually displayed on a workstation by clicking on the Access Granted or Denied event.
- y. Four Zones of Global Anti-Passback: Provide four separate zones per Location that can operate without requiring interaction with the host PC (done at controller level). In addition, each anti-Passback reader can be further designated as Hard, Soft or Timed in each of the four anti-Passback zones.
- z. Global IO Linking: Provide that any Input or Output can link to any other Input or Output within the same Location without requiring interaction with the host PC (done at controller level).

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- aa. Global Code to IO linking: Provide that any access granted event can link to any input or output within the same Location without requiring interaction with the Host PC (done at controller level).
- bb. Alarm Automation Interface (Smart Port): Provide High level interface to central station alarm automation software systems. Allows input alarms to be passed to and handled by automation systems in the same manner as burglar alarms, using an RS-232 ASCII interface.
- cc. Emailing of Alarms: Provide the ability to send alarm notifications by way of Email Groups which shall consist of a single or group of recipients. Within each Email Group, Time Zones shall be available to determine when each group member will receive the alarm notification.
- dd. Alarm Echo Offsite Monitoring: Provide the ability to allow a Same software remote access control system at a central site to provide after-hours monitoring of other Same software primary access control system(s) via dial-up modems.
- ee. Remote Control/Diagnostics: Provide the ability to allow a Same software remote access control system at a central site operator to call the Host PC at another Same software primary access control system and control inputs, outputs and card readers via dial-up modems without performing a download or affecting the downloaded data.
- ff. Visitor Management: Provide for and allow an operator to be restricted to only working with visitors. Shall have ability to enroll codes for visitors and can only assign access levels that have designated as approved for visitors. Provides for an automated Logbook of, visitor name, date and whom visitor contacted.
- gg. Shall support the use of Virtual Outputs that do not physically exist but can be programmed in the same manner as any Relay Output in the system.
- hh. Shall support a First Man In Rule to prevent doors that normally unlock on a schedule from unlocking when weather or other conditions prevent anyone from traveling to or occupying the location or building.
- ii. Shall support a Manager First Rule to be used to keep other employees' cards from gaining access to the building when the manager is not on site.
- jj. Shall support a Two Man Rule requiring that two different cardholders must use their card before they can gain access to a door.
- kk. Shall provide for Hazmat Lockdown situations to quickly lockdown a system during Hazmat alerts, without the need of programming or lengthy downloads.
- ll. Shall support Time Zone Control to quickly disable one Time Zone and/or enable another through Time Zone Linking, for applications that call for multiple schedules to control cards or door locks with the ability to switch from one schedule to another without any programming or Time Zone reassignment.
- mm. Reports: Provide for but not be limited to:
 - 1) Custom History Report Generation: Reports shall be tailored to exact requirements of who, what, when, where, and report parameters can be stored for future recreation of report.
 - 2) Custom History Reports can be previewed, printed to local or network printer or saved to file.
 - 3) Automatic History Report Generator: Provides history reports to be named, saved, and scheduled for automatic generation, printing and/or emailed.
 - 4) Card Holder Reports shall have options to include complete cardholder data or selected parts as well as ability to be sorted by Name, Card number, Imprinted number or by User Defined Fields.
 - 5) Card Holder By Reader Reports: Provide ability to run Card Holder reports based on who has access to a specific reader or group of readers by selecting the readers from a list.
 - 6) Card Holder By Access Level Reports: Provide ability to run Card Holder reports that display everyone that has been assigned to the specified access level.
 - 7) Card Holder by Output Linking Level Reports: Provide ability to run Card Holder reports that display everyone that has been assigned to the specified Output linking level.
 - 8) Card Holder Photo Roster Report: Provide the ability to print from 1 to 50 card holder pictures per page along with any other card holder data as required.
 - 9) Emergency "Who is IN" report (or Muster report): Provide for one Click operation on tool bar to launch report. "Who is IN" must also have ability to be initiated by alarm defined separately by workstation. Input alarm can be any input on any controller.
 - 10) Support for sites that do not have a PC running workstation to print the report from a remote workstation.

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- 11) Management reports to include but not be limited to, Number Of People With Activity, Card Holders Currently On Site, Ins And Outs, Activity Summary sorted by Company, Daily Activity and Card Holders Currently Not On Site.
 - 12) Number of Uses: Provides total number of uses at specified reader. This report is useful for the billing of after-hours HVAC use. Report must have option to be sorted by Cardholder or by Company.
 - 13) Panel Labels report. Provide ability to print out the control panel field documentation including the actual Location of equipment, programming parameters, and wiring identification. The system shall be capable of maintaining system installation data within the system database so that it is available on site at all times.
 - 14) Scheduled Override Report: Allows for a report of Scheduled Overrides programmed in the Workstation screen.
 - 15) Activity/Alarm On Line Printing: Provide activity printers to be used at any workstation, printing all events or just alarms.
 - 16) Device Summary report that will show board type, firmware, and RAM for each device.
- nn. Key Control Software: Provide ability to store what (conventional metal) keys are issued and to whom, along with key construction information. Reports can be generated to list everyone that has possession of a specified key. Key assignments can be included in Card Holder Reports.
- oo. All messages from PC to controllers and controllers to controllers shall be on a polled network that utilizes check summing and acknowledgement of each message. All communication shall be verified and will automatically be buffered and retransmitted if the message is not acknowledged.
- pp. TCP/IP Host PC to Controller Communications: Host PC provides for communications to be redirected through a LAN/WAN to a TCP/IP address, rather than through a conventional serial port connection.
- qq. Regional Time Zone Settings: Provide for the adjustment of Time Zone references for both Workstation PC's and sets of controllers based on their physical locale.
- rr. Selectable Poll Frequency and Message Time Out settings: Provide means to deal with bandwidth and latency issues for TCP/IP, RF and other PC to Controller communications methods by changing the polling frequency and the amount of time the system waits for a response.
- ss. Scheduled Override of individual Input and Outputs. Provide the ability to schedule temporary future date overrides to Arm or Bypass inputs, and Secure or Open Outputs. A scheduled override shall consist of a start time/date and an action to perform coupled with a stop time/date and action to perform.
- tt. Override Groups: Provide Groups (or sets) of inputs and outputs that can be monitored and controlled through one Icon. A summary Icon shall be used to display status of all items in the override group. Override group Icons may be placed on graphic maps and may have Scheduled Overrides applied.
- uu. Automatic and Encrypted Backups: Provide for database and history back-ups to be automatically stored (anywhere on network) and encrypted with a 9-character alpha-numeric password which must be used to restore or read data contained in the back-up. Shall provide ability to set the number of automatic sequential back-ups before the oldest backup becomes overwritten, (FIFO mode).
- vv. Operator Audit Trail: Provide for recording and reporting of all changes made to the database. This option shall have the ability to be toggled off.
- ww. Copy command in database: Provide for like data to be copied and then edited for specific requirements, (eliminates redundant data entry).
- xx. Inputs, outputs, and maps shall have a display order assigned that determine the order shown under status and over-ride windows.
- yy. Cardholder: Provide for but not limited to the following;
- 1) Shall have the ability to create multi-Location access levels combined with the ability to assign an unlimited number of access levels to a card. Each access level may include any combination of doors from any Location. Each door within the access level may have 4 time zones associated with it.
 - 2) Temporary Access Levels: Provide temporary access levels to be assigned to a card using user defined start and stop dates.
 - 3) Shall have the ability to assign an unlimited number of Access Levels per cardholder.
 - 4) Card Use it or Lose it: Shall be able to specify on a per company basis the length of time a card holder can go without using their card before their card is deactivated.

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- 5) Shall have Name search engine with capabilities such as, can search by Last name, First Name, Company, User defined data, Codes not used in "X" days, Skills or by 7 other methods. Shall have ability In Workstation to display anti-Passback status to quickly verify if user is in facility.
 - 6) Multiple De-Activate Dates for Cards: Provide user defined fields to be configured as additional Stop Dates to deactivate any cards assigned to the card holder.
 - 7) Shall have the ability to set a Start/Stop time as well as date for card activation/de-activation.
 - 8) Data Base program shall have Active/De-activate buttons in the tool bar that can quickly change users' status. Simultaneous multiple selections is an option.
 - 9) Batch card printing shall be provided as standard.
 - 10) Default Card data can be programmed to speed data entry for sites where most card data will is similar. What is this?
 - 11) Enhanced ASCII File Import Utility shall be provided to allow the importing of cardholder data and images.
 - 12) Provide a Cards Expire When Used At This Reader option that allows readers to be configured to deactivate cards when a card is used at that device. Typically used at Visitor badge return.
- zz. Shall automatically define an Output (reader- controlled output relay) and Input (door position switch) with the name of the card reader each time a card reader is added to the system to speed data entry.
- aaa. Re-Occurring Holiday Schedules: Provide option for holidays to be set to re-occur each year, preventing holiday from being purged from system once the date passes.
- bbb. The date time shall be displayed and printed in the format that matches that of the host PC, referred to as windows short date format.
5. Optional Enhancements: These enhancements are considered to be optional with the need for additional software and/or hardware.
- a. A PC Master program that allows a PC to perform the polling and communication duties normally handled by a Location's Master panel. Advantages to this configuration are as follows:
 - 1) Communications to the Slave panels can be routed through multiple serial ports and/or TCP/IP LAN/WAN network connections.
 - 2) Greater control can be exerted over the Master to Slave polling frequency. This allows the system to function over slower communication methods.
 - 3) The communications to the Slave panels can be separated into several different channels that operate simultaneously thus providing a substantial increase in the rate of data collection and data distribution.
 - b. A Soft I/O program that provides the ability to integrate other external systems such as HVAC, intercom, fire and elevator control via serial data links between the systems.
 - c. A Hot Swap Redundancy program that provides continued availability of system communications and control through the implementation of Primary and Backup Communications Server PCs.
 - d. A DVR Driver interface that provides the ability to integrate with various OEM Digital Video Recorders thus allowing stored and live video from the DVR to be accessed from within the Access Control program via a LAN/WAN connection.

2.4 HARDWARE

A. Intelligent Controller:

1. Model DSX-1048PKG Intelligent 8 Door I/O Controller:
 - a. Designed for eight-door reader/keypad application.
 - b. Inputs: 32 EOL supervised inputs
 - 1) Each capable of 2, 3, or 4 state point monitoring with trouble reports.
 - c. Outputs: 8 relay, 8-Open collector outputs, 8 pre-warn, 24 LED drivers as follows:
 - 1) 8 - Form C, 5 amp rated relay outputs.
 - 2) 8 - Open collector outputs 100ma
 - 3) 8 - pre-warn outputs for door being held open sounders.
 - 4) 4) 24 - LED output Drivers to show lock status and or valid card read status at the reader or keypad.
 - d. Basic Features:
 - 1) UL 294 and UL 1076 compliant.

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- 2) 2) Complete distributed processing: No reliance on host PC for any decision-making.
- 3) Access verifications for all cards performed at controller.
- 4) Linking: Input to Input, Input to Output, Output to Input, Output to Output, Code to Input and Code to Output Linking. Done locally at controller AND/OR controller to controller within same Location.
- 5) Status LED for each Input
- 6) Status LED for each Output
- 7) Controller Polled LED.
- 8) Separate communication receive and transmit LEDs.
- 9) Processor functioning properly LED.
- 10) Dynamic Battery load test: Programmable using a spare open collector output to trip the Battery Test Input. Battery test may also be manually initiated thru PC at any time.
- 11) Battery Load shed circuit: Once the system is running on battery power the batteries must be disconnected at approximately 9VDC. The batteries must stay disconnected until AC power is restored.
- 12) Controller must report to PC; loss of power, and low battery as separate alarms.
- 13) Status LED for DC power to Controller.
- 14) Real time on board clock/calendar generation that is synchronized with host PC clock/calendar.
- 15) Dynamic memory allocation.
- 16) Change to/from auto buffering of all transactions based on communications status.
- 17) Point to point RS-485 4 wire controller communications allowing up to 4,000 feet between each 1048PKG.
- 18) Wiring Management System that includes wire chases, cable ties and mounting clips.
- 19) Silkscreen detailing displays wiring termination and function of all terminals on controller.
- 20) Controller operating system resides in Flash ROM that is upgradeable thru the Host PC. Upgrades in controller operating system shall NOT require PROM changes.
- e. Power Supplies: DSX-1040PDP (power distribution panel) and DSX-1040CDM (communications distribution module), Included in 1048PKG.
 - 1) 10-15 VDC, 12 VDC nominal / 10A power for controllers. (Battery backed-up).
 - 2) 8-12 VDC 10A / 24 VDC 5.6A power for locks (optional battery backup).
 - 3) VDC .375 amp for 5-volt devices.
 - 4) UL 294 and UL 1076 compliant.
 - 5) AC loss and low battery supervisory outputs.
 - 6) Battery load test control input.
 - 7) Lock power override input.
 - 8) Provides individual fused outputs for 8 locks.
 - 9) Provides for 8 individual sets of termination of Lock wiring and control relay wiring. On removable terminals.
- f. Controller Architecture:
 - 1) RDC 186 20 MHz processor, RAM, ROM, and removable field wiring terminals.
- g. Compatibility:
 - 1) Controller is compatible with any identification device that transmits data using Wiegand, clock/data, or RS-232 ASCII at 1200 baud 8N1. This includes but is not limited to proximity, barium ferrite, bar code, magnetic stripe, Wiegand, keypads, and biometric readers.
- h. Memory:
 - 1) RAM: 512K
 - 2) ROM: 512K Flash
- i. Communications:
 - 1) Via direct serial port, dial-up modem, or TCP/IP. TCP/IP communications require additional hardware.
 - 2) Communication Ports: PC to controller 1 - RS-232 in; 50 feet max. 50 feet – 4,000 feet requires two MCI modules.
 - 3) Controller to controller in the same enclosure; RS232 via the 1040CDM. 1048 to 1048 regenerative RS485 4,000 feet max via the 1040CDM to other enclosures.
 - 4) 1040CDM (communications distribution module) handles RS232 between controllers in the same enclosure and serves as RS485 connection point for other 1040 Series PKG units or 1022 controllers in controller network.
- j. Physical Specifications:

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- 1) Cabinet: DSX-1040E 15.5 inches wide x 22.5 inches tall x 6 inches deep, key locale.
Total Weight: 25.0 lbs.
 - 2) Cabinet: DSX-1040PE 15.5 inches wide x 14 inches tall x 6 inches deep, key locale.
Total Weight: 25.0 lbs.
 - 3) Cabinet Finish: Black powder coat with white silkscreen.
 - 4) Operating Temperature: 32 to 131 degrees F.
 - 5) Operating Humidity: 0-95% RD
 - 6) Battery Charging Output:
Trickle Charge: 13.5 VDC. 500ma, fused.
- B. DSX-LAN Communications Interface with Modem Back-Up
1. Model DSX-LAN / DSX-LAN(M)
 - a. Contains both an RS-232 and RS-485 communication port for connection to any DSX Controller.
 - b. Auto-sensing for both 10 and 100 Mbit networks.
 - c. Auto-duplexing for compatibility with any router.
 - d. Power requirements of only 12 VDC @ 300ma, available from any DSX Controller.
 - e. Can be ordered with Dial-up (M)odem backup for redundant communications.
 - f. Can be programmed through a serial port using KB2CW.
- C. Quadraplexor:
1. Model DSX-1035 Quadraplexor Communications Multiplexer:
 - a. Multi-function, protocol independent communications repeater hub.
 - b. Accepts one RS-232 or RS-485 signal input and supplies one RS-232 signal output and four RS-485 signal outputs.
 - c. Complete with built-in power supply and battery charging circuit.
 - d. Use of device allows branch (star configuration) wiring.
- D. Open collector Output converter:
1. DSX-FRB8 8 Form C relay outputs:
 - a. Converts 8 open collector outputs to Form C relays rated at 5 amps.
 - b. Fuse in series with each common of each relay to protect relay and lock power supply.
 - c. Connects to 1048PKG or 1042PKG.
 - d. LED for each relay to show activation.
- E. Card Reader Cable Noise Filter Model DSX-220:
1. Designed for use in harsh environments where RF or electrical noise is induced on the cable.
 2. Serves as a data line extender for service up to 1500 feet from controller.
 3. Two-piece device, one each installed at controller and the other at the reader, (requires 12VDC power at controller and 12VAC at reader).
- F. Additional Controller Enclosure(s): DSX-1040E.
1. Six Slot Equipment Enclosure with Lock and Key. Accepts 4 1040 Series controllers, one 1040CDM and one expansion slot.
 2. Provided complete with wire channels, conduit knockouts, and wire tie anchors.
 3. Constructed of 18-gage powder coated steel, black color, with white silk-screened cabinet identifications.
 4. Depth: 6 inches deep.
 - a. Face dimensions: [15.75 inches wide x 22.75 inches high]
- G. Card Readers
1. HID multiCLASS Signo Model 20 or 40:
 - a. 13.56 MHz or 125 kHz Single Technology reader.
 - b. Readers shall be compatible with existing District Indala Proximity access cards.
 - c. Provide mullion size readers where required.
- H. Request to Exit Devices
1. Provide for all doors *where indicated on Drawings*.
 2. Tyco T.REX-LT, or equal:
 - a. PIR sensor technology
 - b. Suitable for wall or ceiling mounting

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- c. Two Form C output relays contacts
- d. LED indicator light
- e. Relay latch time adjustable to 60 seconds
- f. Programmable fail safe or fail secure modes.

(Addendum 4)

I. Door Release Pushbuttons

- 1. Door Release Console by ESI, or equal:
 - a. Momentary, SPDT, contacts rated 4 Amps at 28 VDC.
 - b. Plastic housing with mounting flanges, individual pushbuttons for remote door release and Lock-Down button (where applicable).
 - c. Pushbuttons protected by guard ring.

J. Panic Pushbutton Stations

- 1. *Panic Switch Pushbutton; GRI Series GR3045, or equal.*
- 2. *Provide where indicated on Drawings. Coordinate final locations with Owner prior to rough-in.*

(Addendum 4)

2.5 SYSTEM OPERATION AND CONTROL SPECIFICATIONS

A. System Integrity and Performance

- 1. Each controller shall operate as an autonomous intelligent processing unit. It shall be part of a fully distributed processing control network. Each controller shall maintain its own database, in its entirety, necessary for independent operation in its own RAM. It shall make all decisions about access control, alarm monitoring, linking functions and door locking schedules for its operation independent of any other system components.
- 2. When controller is brought on-line all database parameters shall be automatically downloaded to it. After initial download is completed only database changes shall be downloaded to each controller. This shall be referred to as "Incremental downloads" or "Downloading of Changes Only".
- 3. I/O Linking and Anti-Passback functions shall operate globally between all controllers within the same Location without any Host PC intervention. Linking and Anti-Passback functions shall not depend on any decision-making process or macros from the Host PC and shall occur even with the Host PC off line.
- 4. Controller operating system resides in Flash ROM that is upgradeable thru a download from the Host PC. Upgrades in controller operating system shall NOT require PROM changes.
- 5. A Location shall be defined as a loop of up to 64 controllers (128 devices).
- 6. The first controller of every Location shall be designated as the "Master". All subsequent controllers at the same Location shall be designated as "Slaves". Any controller may be selected by dipswitch settings to work as a Master controller. A Master controller shall perform all the same functions as a Slave controller, but it shall also be responsible for polling all Slave controllers and reporting the history transactions to the host PC. The Master controller shall not make any access decisions for the Slave controllers. The Master controller shall be the messenger for information from the controllers to the PC, and from the PC to the controllers.
- 7. Each card reader port of a controller shall be custom configurable for over 230 different card reader or keypad formats. Multiple card reader/keypad formats may be used simultaneously at different controllers and even within the same controller.
- 8. The Controller shall provide a response to all Card Read or Keypad entries in less than .25 seconds regardless of System size.
- 9. All valid codes for a Location shall be downloaded and reside in the controllers. The controllers shall not depend on querying the Host PC database or any other controller or system component for code authorizations.
- 10. All communication between the Host PC & Master controller (Direct, Dial-up or TCP/IP), and between the Master & Slave controllers use a polled communication protocol that checksum and acknowledges (ACK) each message. All communication is verified and will automatically be buffered and retransmitted if it fails to be acknowledged.
- 11. There shall be NO degradation of System performance in the event of a communication loss between the Host PC and the Master controller. The Master controller shall automatically switch to buffer mode storing up to 10,000 events. There shall be NO loss of transactions in System history files until the controller buffer overflows.
- 12. A missing or failed controller shall not degrade the performance of the communicating controllers in the controller communication network. Missing controllers shall be ignored and sampled less often

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- by the Master controller. Any functioning Slave controller not communicating with the Master will automatically switch to buffer mode storing up to 10,000 events.
13. Buffered events shall be handled in a FIFO (First in First Out) mode of operation.
 14. All controllers shall have a built-in dead man reset timer (watchdog circuit) that automatically reboots the controller in the event the processor is interrupted for any reason.
 15. Any controller that is reset or powered up from a non-powered state shall automatically request a parameter download and reboot to its proper working state. This shall happen without any operator intervention.
 16. The System shall provide a means for viewing the Communications Status of the intelligent controllers RS485 Communications loop.
 17. The Communication Status window shall display which controllers are currently communicating, a total count of missed polls since midnight, and which intelligent controller last missed a poll. Missed polls reflect that messages had to be retransmitted and are an indication to the soundness or quality of the controller-to-controller network.
 18. The Communication Status window shall show what type of CPU, what type of Input/Output board, and how much RAM Memory each controller has.
 19. The chance that a controller will allow access to an unauthorized individual under normal operating conditions shall be less than 1 in 10,000.
 20. The chance that an authorized individual will be denied access under normal operating conditions shall be less than 1 in 1,000.
- B. PC to Controller Communications (All Types)
1. The System shall communicate using Serial ports for direct connections, and/or TCP/IP LAN and/or dial-up Modems for connections to Locations.
 2. The System shall be able to use either one or both serial ports for dial-up modems, and either one or both serial ports for direct connect Locations and/or TCP/IP LAN connect Locations.
 3. The serial ports used for communications shall be individually configurable for Direct Communications, Modem Communications Incoming & Outgoing, or Modem Communications Incoming only, or as an ASCII output port.
 4. If more than 2 serial ports are needed, a Windows compatible Multi-Port Communications Board shall be used.
 - a. The outboard multi-port serial board shall connect to an internal PCI bus adapter card. The port expander boards shall have an expandable and modular design. The port expansion modules shall be available in a 4, 8, or 16 Serial Port Configuration that is expandable to 32 or 64 serial ports.
 - b. The Multi-Port Comm. Board shall allow multiple direct connect Masters to be connected to the System.
 - c. the Multi-Port Comm. Board shall allow multiple dial-up modems to be connected to the System.
 5. Direct serial, TCP/IP and Dial-up Modem Communications shall have no difference in monitoring or control of the System with the exception of the connection that must first be made to a dial-up Location.
 6. For TCP/IP communications an option to set the Poll Frequency and Message Response Time Out settings shall be available. This will allow tuning for bandwidth and latency issues associated with network communications.
- C. Direct Serial or TCP/IP PC to Controller Communications
1. The communication software on the PC shall supervise the Controller to PC Communications link.
 2. The communications shall be supervised when using either direct serial port connections, or TCP/IP LAN connections.
 3. Loss of communications to any Master Controller shall result in a Communication loss alarm at all PCs running the communications software. The Master controller shall then automatically buffer events.
 4. When communications are restored to the Master Controller all buffered events shall automatically upload to the PC and any database changes shall automatically be sent to the Master controller.
- D. D. Dial-up Modem PC to Controller Communications
1. The communication software on the PC shall supervise the Controller to PC Communications link during dial-up modem connect times.
 2. The System shall be programmable to routinely poll each of the remote dial-up modem Locations collecting event logs and verifying phone lines each at different time intervals.

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3. The System shall be programmable to dial and connect to all dial-up modem Locations and retrieve the accrued history transactions on an automatic basis as often as once every 10 minutes to once every 9999 minutes.
 4. Failure to Communicate to a dial-up Location 3 times in a row shall result in an alarm at the PC.
 5. Time offset capabilities shall be present so that Locations in a different geographical time zone than the Host PC will be set to and maintained at the proper local time. This feature shall allow for geographical time zones that are ahead or behind the host PC.
 6. The Master of a dial-up modem-connected Location shall automatically buffer all normal transactions until its buffer reaches 80% of capacity. When the transaction buffer reaches 80% the Master controller shall automatically initiate a phone call to the central monitoring PC and upload all transactions.
 7. If an alarm event occurs, the Master controller shall initiate an immediate call to the PC to report the alarm event.
 8. Modem Communications shall allow the use of 9600-baud dial-up modems provided by the manufacture of the System. Modems used at the Master Controller shall be powered and battery backed up by the controller.
- E. Controller to Controller Communications
1. The Controller to Controller Communications shall be a true RS-485, 4-wire, point to point, regenerative (repeater) communications network methodology.
 2. The RS-485 communications signal shall be re-generated at each controller without any additional modules or hardware.
 3. The controller-to-controller communications shall be performed without the use of external modules or devices.
 4. The Master Controller shall supervise the communications to each Slave controller. Communication Loss shall be reported immediately for direct serial port connected Locations. Controller communications loss shall be configurable to initiate a call to the PC for dial-up modem Locations.
- F. Database Downloads
1. Controllers shall initially be downloaded with all Location data.
 2. The System shall download all database changes to the intelligent controllers utilizing automatic non-invasive incremental updates also known as the Downloading of Changes Only.
 3. When data is downloaded from the PC to the Master controller the PC shall request a complete database checksum to check the integrity of the download. If the data checksum does not match the PC, the full data download shall automatically be retransmitted to the Master controller.
 4. When data is downloaded from the Master controller to a Slave controller the Master controller shall request a complete database checksum to check the integrity of the download. If the data checksum does not match the Master, the full data download shall automatically be retransmitted to the Slave controller.
 5. When data is transferred from the Master controller to the Slave controllers the integrity of the data download is verified through checksums. A check sum on each message, each table, and a final table total checksum are calculated. If the checksums do not match the Masters the data shall be automatically retransmitted from the Master to Slave.
 6. If the Master controller is reset for any reason, it shall automatically request a database parameter download from the PC. When the Master is a dial-up modem connect Location, it shall automatically dial the PC, and request and receive the database parameter download. The download shall restore the remote site to its normal working state and shall take place with no operator intervention.
 7. Slave controllers that have lost communication with the Master controller upon restoral shall have their database evaluated by the Master Controller. If the controllers' database is still current the controller is brought back on-line without downloading. If the controllers' database is not current it is brought back on-line and then fully downloaded. This download shall restore the Slave controller to its normal working state and shall take place with no operator intervention.
 8. When changes are made to the database for a dial-up modem Location the PC shall automatically call and download those changes to that Location. No operator commands shall be necessary.
 9. The System shall have the ability to schedule the download of changed data to a dial-up Location (for lower phone rates) between the hours of 2 and 5 AM.
 10. The System shall also allow the data changes to be downloaded immediately or after a programmable delay from 1-999 minutes (prevents system from multiple sequential phone calls when editing a dial-up Locations' data).
- G. Alarm Response and Handling
1. The System shall have manual and automatic responses to incoming point status change or alarms.

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2. Each input shall have the ability to respond automatically with a link to inputs and or outputs, operator response plans, unique sound with the use of WAV files, maps or images that graphically represent the point Location.
 3. Maps shall automatically display for each input assigned to it that has gone into alarm if the option is selected on a per input basis.
 4. Alarm handling shall require a two-step process. When the alarm is first responded to it will be referred to as Acknowledged. This shall silence alarm beeping and any alarm WAV files being played. The alarm is then referred to as acknowledged but Un-Resolved. The next handling of the alarm will give the operator the ability to give a resolution (or operator comment) as to the final disposition of the event. The alarm shall then clear.
 5. Each workstation shall display the total pending alarms and total un-resolved alarms.
 6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
 7. Alarms shall be reported in a real time fashion barring any connection time for non-direct connect (dial-up) Locations to the Host PC where the operator shall be alerted and given an optional response plan or Action Message.
 8. Operator response action messages shall be a minimum of 65,000 characters each with up to 32,000 messages.
 9. Alarms shall be displayed and can be handled from a minimum of 4 different windows.
 - a. The input status window: The status Icon will be overlaid with a large red blinking Icon. Selecting the Icon will acknowledge the alarm.
 - b. The History log transaction window: The name, time, and date will display in red text. Selecting the red text will acknowledge the alarm.
 - c. The Alarm log transaction window: The name, time, and date will display in red verbose. Selecting the red text will acknowledge the alarm.
 - d. The graphic map display: The Icon for the input in alarm will flash with a large red blinking Icon. Selecting the Icon will acknowledge the alarm
 10. Once the operator has acknowledged the alarm, they shall be automatically prompted to enter comments as to the nature of, and action taken on the alarm. The operator comments may be manually entered or selected from a predefined list or a combination of both.
 11. Predefined Operator Comments shall have the ability to be used to resolve alarms where there are regular alarm occurrences. The operator shall have the means to choose from a list instead of typing the same message repeatedly.
 12. The System shall track when and who acknowledged and resolved the alarm.
 13. All identical alarms (from the same alarm point) shall be acknowledged at the same time the operator acknowledges the first one. All identical alarms shall be resolved when the first alarm is resolved. Restoral conditions, if set to be acknowledged shall follow the same operation as just described above for alarms.
 14. The user shall have the ability to manually command inputs to arm, bypass, or follow their Time Zone from the PC with a one-step command.
 15. The System shall have an alarm popup message window and beep that informs the operator of an alarm that is pending. This shall occur even when the alarm monitoring application is not the top window.
 16. The alarm popup message window shall display the alarm and precisely identify the point.
 17. The popup alarm window shall also provide the operator the opportunity to ignore the alarm and clear the popup window or to jump to the alarm-handling window and deal with the alarm and any subsequent alarms.
 18. Alarm Messages shall be receivable by the PC even when the PC is downloading or retrieving a Log from the Location Master.
 19. The System shall have the ability to acknowledge and resolve alarms and control inputs and outputs during a download and Log retrieval.
 20. When a reader-controlled output (relay) is opened the corresponding alarm point will automatically be bypassed.
 21. All alarm points located on System controllers, with the exception of the 1043, shall accommodate 2, 3, and 4-state point monitoring with trouble conditions.
 22. All inputs, with the exception of the 1043 shall be individually programmable with at least 5 different circuit types to choose from.
- H. Input and Output Control
1. All inputs in the System shall have two Icons representations, one for the normal state and one for the abnormal state.

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2. When viewing and controlling inputs the Icons shall respond by changing and updating to the proper Icon to display that input's current state in real time. These Icons shall also display the inputs armed or bypassed state, and whether the input is in the armed or bypassed state due to a time zone or by a manual command.
 3. All outputs in the System shall have two Icon representations, one for the secure (locked) state and one for the open (unlocked) state.
 4. When viewing and controlling outputs the Icons shall respond by changing and updating to the proper Icon for that points current state in real time. These Icons shall also display whether the output is in the secured or open state due to a time zone or by a manual command.
 5. Animation: The Icons used to display status of the Input or Output points shall be constantly updated without any prompting by the operator to show their current real time condition.
 6. The operator shall be able to scroll the list of Inputs or Outputs and press the appropriate button on toolbar or right click to perform the desired function: arm, bypass or set to time zone for inputs, and secure, open, or set to time zone for outputs.
 7. Graphic Maps containing Inputs, Outputs and Override groups:
 - a. Full color Maps shall be importable from most any graphics file format. Maps shall allow for all input, output, and override group Icons to be placed on the maps in an easy one step drag and drop method.
 - b. Maps shall provide real-time display animation and allow for control of all points assigned to it.
 - c. The System shall allow the same inputs, outputs, and override groups to be defined on different maps. There shall also be the ability to navigate from one map to the next that the points are defined on. There shall also reside the ability to order or prioritize the order in which the Maps will be displayed.
 8. Override Groups containing Inputs and Outputs:
 - a. The System shall incorporate override groups that provide the operator with the status and control over user defined "sets" of inputs and outputs with a single Icon.
 - b. The Icon shall change automatically to show the live summary status of all points in that group.
 - c. The Override Group Icon shall provide a method to manually control or set to time zone all points in the group.
 - d. The Override Group Icon shall allow the expanding of the group to show the Icons representing the live status for each point in the group, individual control over each point and the ability to compress the individual Icons back into one summary Icon.
 9. Schedule Overrides of Inputs, Outputs and Override Groups:
 - a. To accommodate temporary schedule changes that do not fall within the holiday parameters the system shall incorporate scheduled overrides individually for each input, output, and override group in the System.
 - b. Each schedule shall be comprised of a minimum of two dates with separate times for each date.
 - c. The first time and date shall be assigned the Override State the point shall advance to, when the time and date become current.
 - d. The second time and date shall be assigned the state in which the point shall return to, when that time and date becomes current.
- I. I/O Linking
1. The System shall support I/O Linking, which is an action initiated by an input, output, or card read that causes a reaction within a group of inputs and/or outputs. Linking to an input controls its armed state. Linking to an output controls it's on/off state.
 2. In regard to the before mentioned Linking characteristics the System shall fully facilitate Input to Input Linking, Input to Output Linking, Output to Output Linking, Output to Input Linking, Code to Input, and Code to Output Linking.
 3. All Input, Output, and Code Linking shall operate on a global level within a Location. Global linking is any input, output, or card read use can initiate a link from any controller in the Location to any inputs and/or outputs on any controller(s) within the same Location without any interaction with the host PC.
 4. The System shall provide Linking initiated by an input change of state or an input alarm.
 5. The System shall provide Linking initiated by the transition of an output from secure to open and the transition from open to secure.
 6. Code to input and/or output linking shall be initiated by a designated code used at a designated reader/keypad.
 7. The reader/keypad used will determine which group of inputs and/or outputs will be activated. That is the same card can cause a different link to occur based on which reader the card was read at.
 8. Responses to links shall include follow, latch, pulse, toggle, and return to time zone.

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9. In addition to inputs and outputs, time zones shall also have the ability to receive a link from an input, output, or card read. Within each time zone definition, there shall be the option for the time zone to be "On" or "Off" when a link is received.

J. LAN Installations

1. The Local Area Network shall allow multi-user capabilities to the system. It shall allow all functions to be executed at every Workstation on the LAN running the WinDSX software.
2. The software, running on a LAN, shall support as few as 2 Workstations or as many as 1000.
3. The System software shall be Local Area Network (LAN) compatible without any software supplements or upgrades.
4. The system shall be compatible with Windows XP Pro Svc Pack 2, Windows Vista Business Svc Pack 1, Windows 7 Pro 32/64 bit, Windows 8 Pro 32/64 bit.
5. The system shall utilize TCP/IP as the primary protocol.
6. The software shall be installed on the local hard disk of each Workstation so that each Workstation shall run the executable files of the program from the local hard disk but reference the shared database on the File Server.
7. One PC shall be designated as the Comm. Server. This PC shall have the actual physical connection to the Intelligent Controllers by way of Direct Serial Port Connection, Dial-Up Phone Modem, or TCP/IP.
8. All Workstations shall have full control capabilities over the controllers. They shall be able to perform all administrative duties such as Reports and Database Management and interact with a local or remote site as operator password privileges allow.

2.6 DATA BASE AND SYSTEM FEATURE SPECIFICATIONS

A. Database Operation

1. The System data management program general layout shall be in a hierarchical menu tree format with simple navigation through expandable menu branches and manipulated with the use of menus and Icons in a main menu and System toolbar.
2. The System shall use standard Icons in the toolbar for Add, Delete, Copy, Print, Capture Image, Activate, Deactivate, and Who-Is-In (Muster) report.
3. The System shall be programmable with English prompts, scrollable menus, and pull-down windows.
4. All data entry shall automatically be checked for duplicate and illegal data. This field verification shall be used to insure proper information is entered into the System.
5. The Database Management Program shall provide a Point and Click approach to data manipulation.
6. Upon making a selection in database, the view window shall immediately display a list of records for the selected topic. From the view window Add, Edit, or Delete commands may be selected. The process of adding, editing or deleting will then return operator to the View Mode giving immediate visual feedback to all the program entries, existing or those just changed.
7. There shall be a memo or note field for each item that is stored in the data. These note fields are useful for storing information about any defining characteristics of the item. These could be but are not limited to; the Location of, what purpose item was entered for, or reasons changes were made.
8. There shall be a next and previous command buttons visible when editing any database field for quickly navigating from one record to the next.
9. There shall be a copy command and copy tool in the tool bar to copy data from one record for the purpose of creating a new similar record.
10. The system shall check all database entries for valid data and shall automatically display an error describing any invalid data.

B. File Management

1. The operator shall be able to backup the System data at any time and may define that backups be performed unattended.
2. The Backup program shall be an integral part of the access control software. The backup System shall be easy to use with menu guidance.
3. The System shall incorporate an Integral Database Backup and Restoration System with selectable target media including any Windows logical drive, Zip drives, and network resources as a minimum.
4. The System Backup feature shall have both a Manual and Automatic mode of operation.
5. The System shall incorporate a Manual and Auto-Backup History feature that allows history to be backed up to a specified target and storage media including Windows compatible logical drives, Zip drives, and network resources as a minimum.
6. The System shall incorporate database restoration features that allow data to be selectively restored.

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7. The backup program shall provide manual operation from any PC on the LAN and shall operate while the system remains operational.
- C. Operator Passwords
1. The software shall support up to 32,000 individual operators each with a unique password.
 2. Each password shall be from 6 to 10 alphanumeric characters.
 3. Passwords shall be capable of being case sensitive.
 4. The password shall be hidden and never displayed when entered.
 5. Each password shall accept a unique and customizable password profile with the ability for several operators to share a password profile.
 6. There shall be 32,000 definable operator password profiles.
 7. One password profile shall be predetermined for access to all functions and areas of the program.
 8. Each password profile may be customized to allow or disallow operator access to any program operation.
 9. All software functions shall have the ability to restrict operators through settings in a password profile.
 10. All database functions such as View, Add, Edit, and Delete shall have the ability to restrict operators by settings in a password profile.
 11. Password restriction shall apply to each input and output individually. This restriction specifies which inputs and outputs the operator is able to manually manipulate.
 12. Password shall be able to restrict which doors an operator can assign access to.
 13. Operators shall use a User Name and Password to log on the System.
 14. The same User Name and Password is used to access all areas and all programs.
 15. Once logged on, only those menu items and functions that the operator is authorized for based on the operator's password profile are displayed.
 16. There shall be an icon that allows the operator to log off without fully exiting the program. User may be logged off but the program will remain running. The logon window shall then be displayed for the next operator.
 17. The system shall have the ability to hide the user name of the previous operator logged on.
 18. Where "Strong or Complex" password utilization is required WinDSX SQL can use Active Directory to authenticate operators. Once allowed in by AD the operator is still controlled by their password profile.
- D. Hardware Location Password
1. There shall be a Location password that will be utilized for PC to Dial-up Modem sites to prevent unauthorized communications with the Location.
 2. Each Location password shall be from 1 to 8 alphanumeric characters.
 - a. The Location Password shall be verified with the dial-up Location Master controller before communication proceeds.
- E. Reports and History
1. All history shall be initially stored on the hard disk of the host PC.
 2. The system shall have the ability to view the History on any workstation or print History to any system printer.
 3. All History Reports shall allow the user to select any date, time, event type, device, output, input, operator, Location, name, or cardholders to be included or excluded from the report.
 4. The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.
 5. Each report shall depict the date, time, event type, event description, device, or input/output name, cardholder company assignment, and the cardholder name or code number.
 6. Each line of a printed report shall be numbered to insure the integrity of the report has not been compromised.
 7. The total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms" the total shall reflect how many alarms occurred during that period.
 8. All reports shall have the 3 following options:
 - a. View on Screen.
 - b. Print to System Printer.
 - c. Save to File with full path statement.
 9. The System shall have the ability to produce a report indicating either:
 - a. The status of the Systems inputs and outputs.
 - b. The inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.

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10. The System shall facilitate a Custom Code List Engine which allows the Access Codes of the System to be sorted and printed according to the following criteria:
 - a. Active, Inactive, or Future Activate or De-activate
 - b. Code number, Name, or Imprinted Card Number
 - c. Company, Location, Access Levels
 - d. Start and Stop Code Range
 - e. Codes that have not been used since X number of days
 - f. In, Out, or Either status
 - g. Codes with Trace Designation
 11. The System shall incorporate a Who Is In (Muster) report; One Button Report for cardholder locating. This report shall contain a count of all persons that are "In", Location wide, and a count with detailed listing of name, date and time of last use, grouped by the last reader used or by the company assignment. This report shall also be generated from a pre-defined alarm input. Any Workstation in the system shall be able to print the report for a particular Location.
 12. The reports of the systems database shall allow options such that every data field may be printed.
 13. The reports of the systems database shall be constructed such that the actual position of the printed data shall closely match the position of the data on the data entry windows.
- F. Graphics:
1. The software shall support 32,000 Graphic Display Maps. The system shall allow the maps to be imported from a minimum of 21 standard formats from another draw or graphics program including AutoCad TM.
 2. All Inputs and Outputs shall have the ability to be placed on any graphic map in a drag and drop method.
 3. Graphic maps shall display automatically the real time state of outputs and inputs in an animated fashion.
 4. Camera Icons shall have the ability to be placed on any graphic map that when selected will open a live video window and display the camera associated with that Icon and provide for real time Pan/Tilt/Zoom control.
 5. Any Input, Output or Camera placed on a map shall allow the ability to Arm or Bypass an input, Open or Secure an output, or control the Pan/Tilt/Zoom function of any camera.
 6. Any alarm input activation shall optionally by input automatically pull up a graphic map associated with the alarm.
 7. Any alarm activation shall give the operator the ability to manually pull up a graphic map associated with the alarm.
 8. The operator shall be able to view the inputs or outputs and the point's name by simply moving the mouse cursor over the point on any graphic map.
 9. All inputs and outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view all Graphic Maps associated with any input or output.
 10. Each graphic map shall have a display order sequence number associated with it to provide a predetermined order when toggled to different views.
 11. Map size shall be configurable for each map.
- G. Help:
1. All main menus shall have a Help option listed.
 2. The System Help selection shall provide a unique and descriptive context sensitive Help System for all selections and functions with the press of one function key.
 3. The Help System shall provide a manner of navigation to any specific topic from within the first Help window.
 4. The help system shall be accessible outside the program.
- H. Access Card/Code Operation and Management:
1. Access authorization shall support verification of the card/code by facility code (if implemented) first, by card/code and/or Pin validation second, by access level (time of day, day of week, date), by anti-Passback status, and by number of uses.
 2. The System shall allow multiple cards/codes to be assigned to a cardholder.
 3. Each card/code assigned to a cardholder shall have the ability for an unlimited number of access levels assigned to it across all Locations. Each access level shall have any combination of doors in it. Each door shall have the ability to have 4 time zones associated with it.
 4. The System shall allow the grouping of Locations that allows cardholder data to be shared by all Locations in the group, thus preventing the redundant data entry.

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5. The System shall facilitate the viewing, building, editing and issuing of access levels from the code entry window, through an Access Level Manager Engine that maintains and coordinates all access levels to prevent duplication or the incorrect building of levels.
 6. The System shall allow a person to be entered into the System for visitor, data tracking or photo ID purposes without assigning that person a card or code.
 7. Key Tracking shall be an integral function of Cardholder data. This shall allow the tracking and accountability of lock hardware keys (metal keys) issued to each cardholder. Reports can be generated displaying all keys assigned to this cardholder or all cardholders that have a specific key.
 8. The System shall provide a special audible and visual annunciation at the PC when a card/code selected to be traced is used at designated trace readers. In addition, cardholder image shall be automatically displayed when a traced card is used at designated trace readers.
 9. The System shall allow each Card Holder to be given either an unlimited number of uses or a number range from 1-9998 that regulates the number of times the card can be used before it is automatically disabled.
 10. The System shall allow cards/codes to be activated and de-activated manually or automatically by date as well as time. The System shall allow for multiple de-activate dates to be pre-programmed.
 11. The System shall have the ability to de-activate cards/codes by company based on lack of use for a pre-defined number of days.
 12. Integral Photo ID Badging and Photo Verification shall use the same database as the Access Control System and may query data from cardholder, company, and other personal information to build a custom ID badge.
 13. Automatic or manual image recall and manual access based on photo verification shall also be a means of access verification and entry.
 14. The System shall allow a means of grouping cardholders together by Company (department) or other characteristic for a more efficient method of reporting on and enabling/disabling cards/codes.
 15. The Access Codes may be up to 12 digits in length.
- I. Facility Codes
1. The System shall accommodate up to 2048 Facility Codes per Location with the option of allowing the Facility Codes to work at all doors or just particular doors.
- J. Operator Comments
1. With the press of one appropriate button on the toolbar the user shall be permitted to make Operator Comments into History at any time.
 2. Automatic prompting of Operator comment shall occur before the resolution of each alarm.
 3. Operator Comments shall be recorded with time, date, and operator number.
 4. Comments shall be sorted and viewed through Reports and History.
 5. The operator comments shall comprise of two parts and either or both may be utilized, predefined or manually entered.
 - a. Manually entered through keyboard data entry (typed) up to 65,000 characters per each alarm.
 - b. Predefined and stored in the database for retrieval upon request.
 6. The system shall have a minimum of 999 Predefined Operator Comments with up to 30 characters per comment. The Operator Comments that can be manually entered shall accept up to 65,000 characters per Comment.
 7. Predefined Operator Comments shall have the ability to be used to resolve alarms where there are regular alarm occurrences. The operator shall have the means to choose from a list instead of typing the same message repeatedly.
- K. Company
1. The System shall provide a means of assigning one of 32,000 company names to a group of cardholders.
 2. Company names may be used to separate cardholders into groups that allow the operator to determine the tenant, vendor, contractor, department, or division of a company the person belongs.
 3. The software shall have the ability to deactivate and re-activate all codes assigned to a particular company with one action.
 4. History reports and code list printouts shall have provisions to be sorted by Company name.
 5. Company names shall provide a means to give managers reports that pertain to their personnel only.
- L. Time Zones
1. The System shall allow up to 32,000 Time Zones for each of the 32,000 Locations.

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2. Each Time Zone shall contain a start and stop time for 7 the days of the week and 3 separate holiday schedules.
 3. A Time Zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm/disarm, when an output shall automatically open/secure, or when cards assigned to an access level shall be denied or granted access.
 4. Dynamically linked bar graphs shall display the resultant active and inactive times for each day and holiday as start and stop times are entered or edited.
 5. The System shall allow for up to 4 different Time Zones to be assigned to any input, output.
- M. Holidays
1. The System shall have provisions for 32,000 Holidays.
 2. Each Holiday shall be defined with MM/DD/YYYY and a description.
 3. Up to 32,000 holidays may be entered in advance.
 4. Holidays shall be defined as a minimum of three types. This will allow for 3 separate holiday schedules.
 5. Holidays shall have an option to be designated as occurrence each year, those shall remain in system and not be purged.
 6. Holidays not designated to occur each year shall be automatically purged from the database after the date expires and a new Holiday is added.
 7. Each Holiday shall have the ability to be assigned to one of three types of Holiday. The type of holiday shall be relative to a time period of one (24) hour period.
 8. Holidays may be created per Location or by Location Group.
- N. Access Levels
1. The System shall allow for 32,000 access levels.
 2. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times.
 3. The System shall allow for access to be restricted to any area by reader and by time. Access Levels shall determine when and where a card is authorized.
 4. The System shall be able to create multiple door and time zone combinations under the same Access Level so that a card may be valid during different time periods at different readers even if the readers are on the same controller.
 5. Each door in an access level shall have the ability to have a minimum of 4 different time zones assigned to it.
 6. The System shall incorporate an Access Level Manager Engine for menu guidance and assistance in creating, managing, and assigning access levels.
 7. The manager shall be accessible from the card data entry window.
 8. When assigning an Access Level, the access level manager engine shall provide door and time zone listings for the operator to choose from.
 9. The system shall allow for the ability to copy form one door assignment up to 4 time zone schedules with one operation for assignment to another door. This shall reduce operator data entry time when creating access levels that use like time zone schedules.
 10. The system shall allow the User to Modify Access Levels in Bulk by first selecting multiple cardholders to be modified.
- O. User Defined Fields
1. The System shall provide a minimum of 99 User Defined Fields for specific information about each access code holder.
 2. User defined fields shall allow up to 50 characters per field.
 3. The title of each field shall be programmable up to 20 characters.
 4. There shall be a "Required" option for each user defined field that when selected forces the user to enter data in the user-defined field before the cardholder record can be saved.
 5. There shall be a "Unique" option for each user defined field that when selected will not allow duplicate data from different cardholders to be entered.
 6. There shall be a "UDF Data is Hidden" option for each user defined field that will require any given operator to have that option available in his/her password profile before that hidden data can be viewed.
 7. Each User defined field shall have data masking in its setup that will require the data to be entered with certain character types in specific spots in the field entry window. This shall facilitate data to have like formatting display.
 8. There shall be an option for each user defined field when selected will define the field as a deactivate date. The selection shall automatically cause the data mask to be formatted with the windows short

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- date format. The system will order these fields and use the next future date of that order to set the deactivate date of that cardholder.
9. There shall be an option to select one of the 99 user defined fields as the Name ID. Data from this type of user-defined field will appear on the same window as the cardholder data entry window.
 10. There shall be a search capability to allow any one user defined field or combination of user defined fields to be searched to find the appropriate cardholder.
 11. String searches shall have the ability to be made on any field in conjunction with any other field searches.
 12. The System shall have the ability to print cardholders based on and organized by the Used Defined Fields.
- P. Code Tracing
1. The System shall perform Code Tracing selectable by cardholder and by reader.
 2. Any code may be designated as a Traced Code with no limit to how many codes can be traced.
 3. Any reader may be designated as a Trace Reader with no limit to which or how many readers can be used for Code Tracing.
 4. When a Traced Code is used at a Trace Reader the Access Granted Message that usually appears on the Monitor window shall be highlighted with a different color than regular messages.
 5. A short singular beep shall occur at the same time the highlighted message is displayed on the window.
 6. The traced cardholder image (if image exists) shall appear on workstations when used at a trace reader.
- Q. Visitor Assignment
1. The system shall have a means of allowing cardholders to be assigned with a visitor designation.
 2. The system shall allow Names to be added that may or may not be assigned codes.
 3. The system shall be able to restrict the access levels that may be assigned to cards that are issued to visitors.
 4. There shall be an option on access levels that will designate an access level as visitor assignable.
 5. The system shall utilize an online log book that during enrollment of a visitor the operator will have access to a search engine that will produce a view all names in the query and by point and click method enter the name of whom is being visited.
 6. The system shall create an event for the history transaction as to the date time the visitor was added and to whom they were to visit.
 7. Once a visitor is enrolled in the system upon the next visit the system shall allow the operator to recall that visitors' cardholder file and by utilizing the search engine query, point and click on the name of the person being visited on this occasion. The system shall create a transaction with visitors' name and whom they were to visit on that date.
 8. The system shall allow designation of any reader as one that deactivates the card after use at that reader, and logs to history as the return of the card.
 9. The system shall have the ability to utilize the visitor designation in searches and reports. Reports shall be able to print all or any visitor activity.
- R. Live Video and Camera Control
1. The system shall provide means of displaying in a separate window the live video from a CCTV source.
 2. The display window shall have separate control buttons to represent Left, Right, Up, Down, Zoom In, Zoom Out, Scan and minimum of two custom command auxiliary controls.
 3. The command structure shall be such that one command string shall be issued when the control button is pressed down and another command shall be sent when the button is released. There shall be an option to automatically repeat the pressed down command as long as the button is pressed.
 4. An Icon shall represent each camera to be controlled. Standard mouse clicking shall open a window that will display the video. If the system is connected to a video switcher it shall automatically send a command through a comm. port to display the requested camera when the Icon is selected.
 5. The system shall provide a minimum of 7 Icons to represent different types of cameras. The ability to import custom Icons shall be provided.
 6. The Icons shall be able to be placed on graphic maps to represent their physical Location. Standard mouse clicking shall open the display window for selected camera.
 7. Each camera shall provide the ability to display and control a specific output on the video display window. The Icon representing the output shall display its real time status and respond in an animated fashion to the data reported from the field controller.

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8. Each Input and Output shall be definable as associated with a camera. Upon selecting an Input or an output the system shall provide a pop-up option window that will allow the camera associated with the point to be displayed.
9. The alarm-handling window shall have a command button that will allow the display of the camera associated with the alarm point.
10. The CCTV video shall be brought into a "Video Capture Card" installed on the PC where video is desired.
11. The system shall have a Next and Previous command buttons on the display window that when selected will allow the user to scroll through all cameras defined on a workstation.
12. The system shall provide that the same camera may be defined several times but display a different controlled Icon. This shall be used when one camera can view several entrances and will facilitate the use of the Next, Previous buttons.

2.7 SYSTEM WIRING

- A. Manufacturers
 1. Commscope
 2. Belden
 3. West Penn
- B. Wiring type and size shall be as recommended by the manufacturer.
- C. All wiring shall be plenum rated.

2.8 INTRUSION DETECTION INTERFACE

- A. Provide equipment and programming as required to interface the Intrusion Detection system specified in section 281600.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Install system components and appurtenances in accordance with the printed instructions.
- B. Provide all necessary interconnections, services, and adjustments required for a complete and operable system.
- C. Install control signal, communications, and data transmission line grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

3.2 WIRING METHODS

- A. Wire Routing: Route all device wiring from each device up into ceiling cavity within metallic conduit in recessed or unfinished areas or within surface raceway for renovated non-fishable areas. Stub all conduits into ceiling cavity and provide protective bushing for each.
- B. Cable Routing: Route cable for all device wiring within accessible ceiling cavities. Install in bridle rings at 4' spacing maximum. No cabling is to lie on or attach to ceiling tile, ducts, pipes, conduits or ceiling suspension wires, rods, or structural members. Provide conduit stubs from devices and panels to the ceiling cavities.
- C. Route all fire alarm wiring from fire alarm panel within metallic conduit up into nearby ceiling cavity and connect to the wiring system indicated in A and B above. Provide bushings at conduit ends.
- D. Provide raceways for cabling in all open structure spaces.

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3.3 FIELD QUALITY CONTROL

- A. Testing:
 - 1. Supply a proposed acceptance test procedure.
 - 2. Testing of system shall be the sole responsibility of the Contractor.
 - 3. Communications tests:
 - a. Controllers to manager server.
 - b. Manager server to client.
 - c. Remote dial-up support.
- B. Inspection:
 - 1. Provide an on-sight, factory-trained technician to assist, advise or manage installing personnel.
 - 2. All final connections shall be made under the direct supervision of the Systems Integrator.
- C. Field Service:
 - 1. Provide first line support for both the hardware and software properties of the selected system.
 - 2. Provided second line support directly from the manufacturer for all component and computer hardware and all operating and application software that comprise the complete system.
 - 3. Determine and report all problems to the manufacturer's customer service departments.
 - 4. Support shall be available to the integrator via the following methods:
 - a. Phone inquiries.
 - b. Direct dial-in to the customer system for remote system troubleshooting by a qualified Field Service Engineer.
 - c. On-site visits if required, upon approval by the manufacturer's Customer Service Manager.

3.4 ON-SITE COMMISSIONING AND TRAINING

- A. The installing company shall provide direct participation in the on-site commissioning activity of new systems. Not less than 16 hours of on-site training shall be provided for a maximum of 6 representatives of Owner.
- B. Provide systems administrator that is factory trained with the expertise on installing, configuring and commissioning the system to the customer's specific requirements; and to provide on-site training on system operation and administration.
- C. On-site shall be available for system administrators, Operators and other qualified personnel.
- D. On site commissioning shall include:
 - 1. Hardware set-up and testing.
 - 2. Preventative maintenance and troubleshooting training.
 - 3. End User training.
 - 4. Database configuration and build assistance.

3.5 FINAL ACCEPTANCE

- A. Perform the following performance standards before final acceptance:
 - 1. Operate all mechanical devices without down time for a period of 10 days
 - 2. Operate all electronic devices and equipment without downtime or programming problems for a period of 30 days.
 - 3. Upon completion of system testing and before the acceptance cycle, provide 2 copies of system manual to Owner.

END OF SECTION 28 10 00

SECTION 28 10 00 – ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Electronic access control system components, including:
 - a. Access control
 - b. Security:
 - 1) Threat Level Management
 - 2) Time Zones controlled with Linking Logic
 - 3) Virtual Outputs
 - 4) Point Monitoring
 - 5) Photo ID Badging
 - 6) Guard Tour
 - 7) Time and Attendance
 - 8) Key Tracking
 - 9) Image Recall with Historic and User Accountability Reporting
 - 10) Live CCTV display/control
 - 11) Interface with CCTV and Central Station Automated Alarm Systems
 - 12) Digital Video Recorder Integration
- B. Related Sections:
 - 1. Division 28 16 00 – Intrusion Detection

1.3 SYSTEM OVERVIEW

- A. PC based: The system is a PC based Building/Facility Management and Monitoring System used to control and monitor personnel and alarm activity. The DSX system provides 5 different controllers that offer various configurations of card reader inputs, relay outputs and alarm inputs. These controllers can be combined to provide the exact number of inputs and outputs required for each application. DSX controllers use fully distributed database architecture with real-time processing performed at each controller.
- B. Distributed Processing: This fully distributed processing provides that all information (time, date, valid codes, access levels, etc) is downloaded to the controllers so that each controller makes its own access control decisions. There are no hierarchical or intermediate processors to make decisions for the controllers. Also, the PC is not required to make any decisions for the controllers including any global functions. This provides Instant response to card reads regardless of system size. This also provides for no degradation of system performance in the event of communication loss to the host (or actual loss of host). All time zones, access levels, linking events, holiday schedules, and global functions remain operational. Upon communication loss to the host all controllers shall automatically buffer event transactions until the host communications is restored, at which time the buffered events will be automatically uploaded to the host. The system maintains full feature capability regardless of the style of the communications from the PC. This means that DSX dial-up modem sites can utilize all standard features like linking between controllers without the PC needing to be online.
- C. System Size: The system is designed to support up to 32,000 separate Locations using a single PC with combinations of direct connect, dial-up or TCP/IP LAN connections to each Location. DSX defines a loop of up to 64 controllers as one Location. Each Location has its own database and history at the host PC.

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Locations may be combined to share a common database and create a very large network of controllers. Each Location can have up to 128 devices.

- D. Intelligent Controllers: Each DSX controller is an Intelligent Control Unit. The first controller of every Location is designated as the "Master". All subsequent controllers at the same Location are designated as "Slaves". Any DSX controller may be selected by dipswitch settings to work as the Master controller. The Master controller performs all the same functions as a Slave controller, but it is also responsible for polling all Slave controllers and communicating with the host PC. The Master controller does not make any access decisions for the Slave controllers. It is simply the messenger for information from the controllers to the PC and for information from the PC to the controllers.
- E. Controller operating system resides in Flash ROM on each controller. It is upgradeable thru a download from the Host PC to each of the 1040 Series and 1022 controllers in the system. Upgrades in controller operating system shall NOT require PROM changes.
- F. Processing Power: Each intelligent controller uses an Intel microprocessor (same as a PC) as its engine. In a large system, the total processing may approach, or even exceed that of a Mini Computer. Instead of all the processing power being centralized in one "Mini" it is distributed throughout the system.

1.4 SYSTEM REQUIREMENTS

- A. Software Requirements:
 - 1. WinDSX is compatible with XP Pro Svc Pack 2, Windows Vista Business Svc Pack 1, Windows 7 Pro 32/64 bit, Windows 8 Pro 32/64 bit. Server platforms include Server 2000, 2003, 2008, and 2008 R2.
 - 2. WinDSX-SQL program utilizes Microsoft SQL Server 2005 Svc Pack 3 /2008™
 - 3. 2008 R2, and SQL 2012 for database deployment and management.
 - 4. Multi-user and multi-tasking capability allowing for independent activities and monitoring to occur simultaneously at different Workstation PCs.
 - 5. Utilize graphical user interface with simple pull-down menus and a menu tree format that conform to interface guidelines defined by Microsoft Corporation.
 - 6. Allow for language localization.
 - 7. Allow LAN/WAN network applications, using TCP/IP protocol, with up to 1000 Workstation PCs.
 - 8. System shall be site licensed, not seat licensed.
 - 9. System shall have open architecture that allows importing and exporting of data and ability to interface with other systems.
 - 10. Operator Identification logon password protected.
- B. Hardware Requirements:
 - 1. Comm Server PC: Windows XP Pro, Vista Business, Windows 7 Pro, or Windows 8 Pro - PC with a 2.8 GHz Pentium processor / 2GB RAM (minimum) or greater depending on system scope. Server 2003, and 2008/R2 will work but not required.
 - 2. Workstation PC: Windows XP Pro, Vista Business, Windows 7, Windows 8 Professional PC with a 2.8 GHz Pentium processor / 2GB RAM (minimum) or greater depending on system scope.
 - 3. Other requirements as indicated herein.

1.5 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Minimum of 10 years experienced in providing security access control components for projects of similar nature and complexity.
 - 2. Maintain a 24-hour toll free telephone assistance line for installing dealer support.
- B. Installer:
 - 1. Minimum of 5 years' experience in performing work of this section who has specialized in the installation of work similar to that required for this project.
 - 2. Have at least one technician trained by the manufacturer.
 - 3. Maintain adequate supply of replacement parts for system components provided.

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- C. Regulatory Requirements: Installed products shall meet standards of a recognized testing laboratory (UL or comparable).

1.6 SUBMITTALS

- A. Submit in accordance with requirements of Section 01 33 00.
- B. Shop Drawings: Detailing all connected devices, of sufficient detail to adequately communicate that recommended software meets access system requirements, including:
 - 1. System device locations on architectural floor plans.
 - 2. Full schematic wiring information for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at devices.
 - 3. A complete access control system one-line block diagram.
 - 4. System sequence operation description.
- C. Product Data:
 - 1. Manufacturer's data for all material and equipment, including terminal devices, local processors, computer equipment, access cards, and any other equipment required for the complete access management and alarm monitoring system.
 - 2. System description, including analysis and calculations used in sizing equipment, and also indicating how equipment will operate as a system to meet the performance requirements of the access control and alarm monitoring system.
 - 3. A description of the operating system and application software.
- D. Contract Close-out Submittals:
 - 1. Operating instructions.
 - 2. Recommended maintenance required and maintenance intervals.
 - 3. Parts list, including wiring and connection diagrams.
 - 4. Record Documents: Maintained on a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the access control and alarm monitoring system, accurately reflecting all changes and additions to the access control and alarm monitoring system.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Section 01 60 00.
 - 1. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
 - 2. Store materials protected from exposure to harmful environmental conditions and at temperature conditions recommended by manufacturer.
 - 3. Handle products and systems in accordance with manufacturer's instructions.

1.8 WARRANTY

- A. Project Warranty: Comply with requirements of Section 01 78 36.
- B. Manufacturer's Warranty: Submit manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRONIC ACCESS CONTROL

- A. Manufacturer:
 - 1. DSX Access Systems, Inc.
10731 Rockwall Road

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Dallas, Texas 75238
(214) 553-6140 voice
(214) 553-6147 facsimile
(800) 346-5288 voice

- B. Local Authorized Distributor:
1. Electronic Systems Installers, Inc.
56 N. Queen St.
York, PA 17403
Mark Nardontonia: 717-843-9955; mark@securityesi.com

2.2 SERVER or WORKSTATION CONFIGURATION

- A. 100% IBM compatible PC approved by Microsoft Corporation for running the Microsoft Windows Windows XP Pro, Vista Business, Windows 7 Pro, or Windows 8 Pro - PC with a 2.8 GHz Pentium processor / 2GB RAM (minimum) or greater depending on system scope. Server 2003, and 2008/R2 will work but not required.
- B. Processors:
1. Pentium 2.8 GHz / 2GB RAM (minimum) Host PC single PC, single Location system, or LAN Workstation for single Location system.
 2. Pentium 3.3 GHz / 2GB RAM (minimum) for LAN Comm. Server or File Server for single Location.
 3. Pentium 3.3 GHz / 4GB RAM (minimum) for LAN Comm. Server and/or combination File Server for multiple Location system.
- C. Operating System: XP Pro Svc Pack 2, Windows Vista Business Svc Pack 1, Windows 7 Pro 32/64 bit, Windows 8 Pro 32/64 bit. Server platforms include Server 2000, 2003, 2008, and 2008 R2.
- D. Hard Disk: 1 Gigabyte free space.
- E. Drives: 16x CD-ROM drive or higher.
- F. Sound Card: Windows compatible; required for sound operations; not required for system operation.
- G. Super VGA monitor, 800 x 600 pixels minimum resolution; 17-inch or larger recommended.
- H. Backup Device: Windows Compatible backup gear.
- I. Peripherals:
1. Serial Ports: Minimum of 1 for either direct or dial-up modem communications.
 2. Mouse: Microsoft IntelliMouse or equivalent recommended but not required.
 3. Modem: DSX provided external dial-up modem only.
- J. LAN:
1. Adapter Card: Required for LAN applications only. 100Mbit is optimum.
 2. If no LAN is required, an MS Loopback Adapter shall be used.
- K. Printer: All Windows XP Pro / Vista Business / Windows 7 /Windows 8 - supported printers; required for transaction hard copy. Not required for system operation.

2.3 SOFTWARE

- A. Software: WinDSX-SQL Software, complete with the following features and functions:
1. Access control and alarm monitoring system that conforms to the programming and interface guidelines defined by Microsoft Corporation for XP Pro Svc Pack 2, Windows Vista Business Svc Pack 1, Windows 7 Pro 32/64 bit, Windows 8 Pro 32/64 bit, Windows 2003/2008/2008 R2 Server or Microsoft SQL Server 2005/2008/2008 R2 or 2012 compatible software.
 2. Basic Functions:
 - a. Access Control

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- b. Activity Monitoring
 - c. Database Management
 - d. Database Reporting
 - e. Point status and overrides.
3. System Capacities:
- a. Support a minimum of 32,000 Locations having grouping capabilities to share cardholder databases between sites.
 - b. Support a minimum of 4,096,000 readers or 128 reader-controlled doors per Location.
 - c. Support a minimum of 170 different card reader formats.
 - d. Support 1.6-billion cardholders total or up to 50,000 access codes/cards per Location.
 - e. Support a minimum of 32,000 supervised alarm inputs or a minimum of 2048 per Location.
 - f. Support a minimum of 32,000 programmable outputs or a minimum of 2048 per Location.
 - g. Support up to 32,000 facility codes (site codes) total or a minimum of 2048 per Location.
 - h. Support a minimum of 32,000 time zones or a minimum of 2048 per Location with each time zone having 3 holiday overrides.
 - i. Support a minimum of 32,000 companies/card holder groups.
 - j. Support a minimum of 32,000 self-purging/auto-renewing holidays.
 - k. Support a minimum of 99 user defined fields per Location.
 - l. Support a minimum of 32,000 system operators.
 - m. Support a minimum of 32,000 password profiles to determine accessibility of system functions for each operator.
 - n. Support a minimum of 999 operator comments.
 - o. Support a minimum of 32,000 graphic alarm maps for full input, output, CCTV control, DVR control, and alarm handling.
 - p. Support a minimum import of 21 graphic file types for maps.
 - q. Support a minimum of 32,000 custom action messages per Location to instruct operator on action required when alarm is received.
 - r. Support a minimum of 32,000 ASCII output messages per Location for use to interface with CCTV and pager systems.
 - s. Support a minimum of 32,000 input to output links.
 - t. Support a minimum of 32,000 code to output links.
 - u. Support a minimum of 999 guard tours.
 - v. Each controlled entry/exit shall have the ability to be locked (secured) and unlocked (open) up to 4 times a day through time zone programming.
 - w. Each monitored input shall have the ability to be armed and disarmed up to 4 times a day through time zone programming.
 - x. Each reader/keypad shall have the ability to be enabled/disabled up to 2 times a day through time zone programming.
 - y. Each card/code shall have the ability to be enabled/disabled up to 4 times per day per entry point through access level programming.
 - z. Provide for support up to 9999 cameras displayed per workstation with live video and Pan, Tilt, Zoom, Scan and Auxiliary controls in video window.
 - aa. Support a minimum of 32,000 Access Levels.
 - bb. Support a minimum of 4 Anti-Passback zones per Location.
4. Basic System Features: These features are considered to be standard without the need for any add-on software or hardware.
- a. Shall have up to 1000 Workstations with one site license.
 - b. Shall have the ability for the main Communications engine portion of the software, or CS.EXE, to run as a service, eliminating the need for an OS logon.
 - c. Shall have built in prevention for multiple comm servers running at the same time when the software is setup incorrectly.
 - d. Each workstation shall have access to all features if password profile allows. In addition, if workstation is used for other tasks (applications) system has option of having an Alarm Pop-up window appear to alert of pending alarms while the operator is using some other program.
 - e. Password profiles shall be individually customized to allow or disallow operator access to any program function for each Location.
 - f. Workstation Event Filtering: Shall allow user to define events and alarms that will be displayed at each workstation. Each workstation shall be able to define and assign time zone-controlled filters. In addition, if an alarm is unacknowledged (not handled by another workstation) for a preset amount of time the alarm will automatically appear on the filtered workstation.
 - g. Shall have the ability to sort the location tree by name in Workstation.

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- h. Stackable Device Types: Shall allow for a different Wiegand Device Type to be assigned to each Device and all Devices within the same Location sharing the various formats between them.
- i. Threat Level Management: With a click of a mouse, press of a button, or presentation of a Card, the system shall be instantly reconfigured to coincide with the Homeland Security Advisory System and meet any heightened security requirements.
- j. CCTV Alarm Interface: Shall allow commands to be sent to CCTV systems during alarms (or input change of state) thru serial ports.
- k. Animated Response Graphics: Provide for highlighting Alarms with flashing Icons on graphic maps. The current status of alarm inputs and outputs shall be displayed and constantly updated to display changes in real time through animated Icons.
- l. Provide the ability to view and control cameras from the graphic maps.
- m. Multimedia Alarm Annunciation: Provide for WAV files to be associated with alarm events for audio annunciation or instructions.
- n. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, and/or option of requiring the operator to enter a comment about disposition of alarm.
- o. Provide 99 User Defined Fields for cardholder data. System shall have the ability to run searches and reports off of any combination of these fields. Each UDF can be configured with any combination of the following features. MASK: Determines a specific format that data must comply with. REQUIRED: Operator is required to enter data into field before saving. UNIQUE: Data entered must be unique. DE-ACTIVATE DATE: Data entered will be evaluated as an additional de-activate date for all cards assigned to this cardholder. NAME ID: Data entered will be considered a unique id for the cardholder. AUTO INCREMENTING CARD NUMBER: Badge serial number that prompts the operator to increment the number each time the badge is printed. UDF DATA IS HIDDEN: The system shall also provide the ability to restrict the viewing of certain UDFs containing sensitive information on a field-by-field basis. SELECT DATA FROM LIST: This allows data to be predefined and lets the user pick one of the selections from a drop-down list. The choices and the order in which they are viewed can be predefined. EMAIL ADDRESS: Select this if the entries in this field are Email Addresses. There must be an Email Address – User Defined Field for the implementation of Email Groups and Email Alarm Notification. Any Card Holder to be in an Email Group to receive alarm notifications must have their Email Address defined in this UDF. This must be the full and proper Email Address (no aliases allowed).
- p. Time and Attendance reporting shall be provided to match in/out reads and display cumulative time in for each day and cumulative time in for length of the report.
- q. Guard Tour: Shall provide ability to Plan, Track and Route tours. Shall produce alarm during tour if guard fails to make a station. Tours can be programmed for sequential or random tour station order.
- r. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
- s. Floor Select Elevator Control and Reporting: Provide for any Card read to activate any floor from the appropriate Cab and report what floor was selected by which cardholder.
- t. After Hours HVAC control: Provide for any Card read to activate or control individual HVAC zones based on access and linking level.
- u. A means for importing of custom Icons for representation of Inputs, Outputs, or Cameras shall be provided.
- v. Photo ID Badging: Provide ability to import images from bitmap file formats, digital cameras, TWAIN cameras, scanners, or live video. Allows image cropping and editing, WYSIWYG badge building application, and full badge printing/print preview capabilities.
- w. Photo Recall on Card Use: Provide means that Images can be automatically displayed on a workstation in response to any card read on any reader, as dictated by Time zone per card reader.
- x. Photo Recall on Event Selection: Provide means that Images can be manually displayed on a workstation by clicking on the Access Granted or Denied event.
- y. Four Zones of Global Anti-Passback: Provide four separate zones per Location that can operate without requiring interaction with the host PC (done at controller level). In addition, each anti-Passback reader can be further designated as Hard, Soft or Timed in each of the four anti-Passback zones.
- z. Global IO Linking: Provide that any Input or Output can link to any other Input or Output within the same Location without requiring interaction with the host PC (done at controller level).

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- aa. Global Code to IO linking: Provide that any access granted event can link to any input or output within the same Location without requiring interaction with the Host PC (done at controller level).
- bb. Alarm Automation Interface (Smart Port): Provide High level interface to central station alarm automation software systems. Allows input alarms to be passed to and handled by automation systems in the same manner as burglar alarms, using an RS-232 ASCII interface.
- cc. Emailing of Alarms: Provide the ability to send alarm notifications by way of Email Groups which shall consist of a single or group of recipients. Within each Email Group, Time Zones shall be available to determine when each group member will receive the alarm notification.
- dd. Alarm Echo Offsite Monitoring: Provide the ability to allow a Same software remote access control system at a central site to provide after-hours monitoring of other Same software primary access control system(s) via dial-up modems.
- ee. Remote Control/Diagnostics: Provide the ability to allow a Same software remote access control system at a central site operator to call the Host PC at another Same software primary access control system and control inputs, outputs and card readers via dial-up modems without performing a download or affecting the downloaded data.
- ff. Visitor Management: Provide for and allow an operator to be restricted to only working with visitors. Shall have ability to enroll codes for visitors and can only assign access levels that have designated as approved for visitors. Provides for an automated Logbook of, visitor name, date and whom visitor contacted.
- gg. Shall support the use of Virtual Outputs that do not physically exist but can be programmed in the same manner as any Relay Output in the system.
- hh. Shall support a First Man In Rule to prevent doors that normally unlock on a schedule from unlocking when weather or other conditions prevent anyone from traveling to or occupying the location or building.
- ii. Shall support a Manager First Rule to be used to keep other employees' cards from gaining access to the building when the manager is not on site.
- jj. Shall support a Two Man Rule requiring that two different cardholders must use their card before they can gain access to a door.
- kk. Shall provide for Hazmat Lockdown situations to quickly lockdown a system during Hazmat alerts, without the need of programming or lengthy downloads.
- ll. Shall support Time Zone Control to quickly disable one Time Zone and/or enable another through Time Zone Linking, for applications that call for multiple schedules to control cards or door locks with the ability to switch from one schedule to another without any programming or Time Zone reassignment.
- mm. Reports: Provide for but not be limited to:
 - 1) Custom History Report Generation: Reports shall be tailored to exact requirements of who, what, when, where, and report parameters can be stored for future recreation of report.
 - 2) Custom History Reports can be previewed, printed to local or network printer or saved to file.
 - 3) Automatic History Report Generator: Provides history reports to be named, saved, and scheduled for automatic generation, printing and/or emailed.
 - 4) Card Holder Reports shall have options to include complete cardholder data or selected parts as well as ability to be sorted by Name, Card number, Imprinted number or by User Defined Fields.
 - 5) Card Holder By Reader Reports: Provide ability to run Card Holder reports based on who has access to a specific reader or group of readers by selecting the readers from a list.
 - 6) Card Holder By Access Level Reports: Provide ability to run Card Holder reports that display everyone that has been assigned to the specified access level.
 - 7) Card Holder by Output Linking Level Reports: Provide ability to run Card Holder reports that display everyone that has been assigned to the specified Output linking level.
 - 8) Card Holder Photo Roster Report: Provide the ability to print from 1 to 50 card holder pictures per page along with any other card holder data as required.
 - 9) Emergency "Who is IN" report (or Muster report): Provide for one Click operation on tool bar to launch report. "Who is IN" must also have ability to be initiated by alarm defined separately by workstation. Input alarm can be any input on any controller.
 - 10) Support for sites that do not have a PC running workstation to print the report from a remote workstation.

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- 11) Management reports to include but not be limited to, Number Of People With Activity, Card Holders Currently On Site, Ins And Outs, Activity Summary sorted by Company, Daily Activity and Card Holders Currently Not On Site.
 - 12) Number of Uses: Provides total number of uses at specified reader. This report is useful for the billing of after-hours HVAC use. Report must have option to be sorted by Cardholder or by Company.
 - 13) Panel Labels report. Provide ability to print out the control panel field documentation including the actual Location of equipment, programming parameters, and wiring identification. The system shall be capable of maintaining system installation data within the system database so that it is available on site at all times.
 - 14) Scheduled Override Report: Allows for a report of Scheduled Overrides programmed in the Workstation screen.
 - 15) Activity/Alarm On Line Printing: Provide activity printers to be used at any workstation, printing all events or just alarms.
 - 16) Device Summary report that will show board type, firmware, and RAM for each device.
- nn. Key Control Software: Provide ability to store what (conventional metal) keys are issued and to whom, along with key construction information. Reports can be generated to list everyone that has possession of a specified key. Key assignments can be included in Card Holder Reports.
- oo. All messages from PC to controllers and controllers to controllers shall be on a polled network that utilizes check summing and acknowledgement of each message. All communication shall be verified and will automatically be buffered and retransmitted if the message is not acknowledged.
- pp. TCP/IP Host PC to Controller Communications: Host PC provides for communications to be redirected through a LAN/WAN to a TCP/IP address, rather than through a conventional serial port connection.
- qq. Regional Time Zone Settings: Provide for the adjustment of Time Zone references for both Workstation PC's and sets of controllers based on their physical locale.
- rr. Selectable Poll Frequency and Message Time Out settings: Provide means to deal with bandwidth and latency issues for TCP/IP, RF and other PC to Controller communications methods by changing the polling frequency and the amount of time the system waits for a response.
- ss. Scheduled Override of individual Input and Outputs. Provide the ability to schedule temporary future date overrides to Arm or Bypass inputs, and Secure or Open Outputs. A scheduled override shall consist of a start time/date and an action to perform coupled with a stop time/date and action to perform.
- tt. Override Groups: Provide Groups (or sets) of inputs and outputs that can be monitored and controlled through one Icon. A summary Icon shall be used to display status of all items in the override group. Override group Icons may be placed on graphic maps and may have Scheduled Overrides applied.
- uu. Automatic and Encrypted Backups: Provide for database and history back-ups to be automatically stored (anywhere on network) and encrypted with a 9-character alpha-numeric password which must be used to restore or read data contained in the back-up. Shall provide ability to set the number of automatic sequential back-ups before the oldest backup becomes overwritten, (FIFO mode).
- vv. Operator Audit Trail: Provide for recording and reporting of all changes made to the database. This option shall have the ability to be toggled off.
- ww. Copy command in database: Provide for like data to be copied and then edited for specific requirements, (eliminates redundant data entry).
- xx. Inputs, outputs, and maps shall have a display order assigned that determine the order shown under status and over-ride windows.
- yy. Cardholder: Provide for but not limited to the following;
- 1) Shall have the ability to create multi-Location access levels combined with the ability to assign an unlimited number of access levels to a card. Each access level may include any combination of doors from any Location. Each door within the access level may have 4 time zones associated with it.
 - 2) Temporary Access Levels: Provide temporary access levels to be assigned to a card using user defined start and stop dates.
 - 3) Shall have the ability to assign an unlimited number of Access Levels per cardholder.
 - 4) Card Use it or Lose it: Shall be able to specify on a per company basis the length of time a card holder can go without using their card before their card is deactivated.

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- 5) Shall have Name search engine with capabilities such as, can search by Last name, First Name, Company, User defined data, Codes not used in "X" days, Skills or by 7 other methods. Shall have ability In Workstation to display anti-Passback status to quickly verify if user is in facility.
 - 6) Multiple De-Activate Dates for Cards: Provide user defined fields to be configured as additional Stop Dates to deactivate any cards assigned to the card holder.
 - 7) Shall have the ability to set a Start/Stop time as well as date for card activation/de-activation.
 - 8) Data Base program shall have Active/De-activate buttons in the tool bar that can quickly change users' status. Simultaneous multiple selections is an option.
 - 9) Batch card printing shall be provided as standard.
 - 10) Default Card data can be programmed to speed data entry for sites where most card data will is similar. What is this?
 - 11) Enhanced ASCII File Import Utility shall be provided to allow the importing of cardholder data and images.
 - 12) Provide a Cards Expire When Used At This Reader option that allows readers to be configured to deactivate cards when a card is used at that device. Typically used at Visitor badge return.
- zz. Shall automatically define an Output (reader- controlled output relay) and Input (door position switch) with the name of the card reader each time a card reader is added to the system to speed data entry.
- aaa. Re-Occurring Holiday Schedules: Provide option for holidays to be set to re-occur each year, preventing holiday from being purged from system once the date passes.
- bbb. The date time shall be displayed and printed in the format that matches that of the host PC, referred to as windows short date format.
5. Optional Enhancements: These enhancements are considered to be optional with the need for additional software and/or hardware.
- a. A PC Master program that allows a PC to perform the polling and communication duties normally handled by a Location's Master panel. Advantages to this configuration are as follows:
 - 1) Communications to the Slave panels can be routed through multiple serial ports and/or TCP/IP LAN/WAN network connections.
 - 2) Greater control can be exerted over the Master to Slave polling frequency. This allows the system to function over slower communication methods.
 - 3) The communications to the Slave panels can be separated into several different channels that operate simultaneously thus providing a substantial increase in the rate of data collection and data distribution.
 - b. A Soft I/O program that provides the ability to integrate other external systems such as HVAC, intercom, fire and elevator control via serial data links between the systems.
 - c. A Hot Swap Redundancy program that provides continued availability of system communications and control through the implementation of Primary and Backup Communications Server PCs.
 - d. A DVR Driver interface that provides the ability to integrate with various OEM Digital Video Recorders thus allowing stored and live video from the DVR to be accessed from within the Access Control program via a LAN/WAN connection.

2.4 HARDWARE

A. Intelligent Controller:

1. Model DSX-1048PKG Intelligent 8 Door I/O Controller:
 - a. Designed for eight-door reader/keypad application.
 - b. Inputs: 32 EOL supervised inputs
 - 1) Each capable of 2, 3, or 4 state point monitoring with trouble reports.
 - c. Outputs: 8 relay, 8-Open collector outputs, 8 pre-warn, 24 LED drivers as follows:
 - 1) 8 - Form C, 5 amp rated relay outputs.
 - 2) 8 - Open collector outputs 100ma
 - 3) 8 - pre-warn outputs for door being held open sounders.
 - 4) 4) 24 - LED output Drivers to show lock status and or valid card read status at the reader or keypad.
 - d. Basic Features:
 - 1) UL 294 and UL 1076 compliant.

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- 2) 2) Complete distributed processing: No reliance on host PC for any decision-making.
- 3) Access verifications for all cards performed at controller.
- 4) Linking: Input to Input, Input to Output, Output to Input, Output to Output, Code to Input and Code to Output Linking. Done locally at controller AND/OR controller to controller within same Location.
- 5) Status LED for each Input
- 6) Status LED for each Output
- 7) Controller Polled LED.
- 8) Separate communication receive and transmit LEDs.
- 9) Processor functioning properly LED.
- 10) Dynamic Battery load test: Programmable using a spare open collector output to trip the Battery Test Input. Battery test may also be manually initiated thru PC at any time.
- 11) Battery Load shed circuit: Once the system is running on battery power the batteries must be disconnected at approximately 9VDC. The batteries must stay disconnected until AC power is restored.
- 12) Controller must report to PC; loss of power, and low battery as separate alarms.
- 13) Status LED for DC power to Controller.
- 14) Real time on board clock/calendar generation that is synchronized with host PC clock/calendar.
- 15) Dynamic memory allocation.
- 16) Change to/from auto buffering of all transactions based on communications status.
- 17) Point to point RS-485 4 wire controller communications allowing up to 4,000 feet between each 1048PKG.
- 18) Wiring Management System that includes wire chases, cable ties and mounting clips.
- 19) Silkscreen detailing displays wiring termination and function of all terminals on controller.
- 20) Controller operating system resides in Flash ROM that is upgradeable thru the Host PC. Upgrades in controller operating system shall NOT require PROM changes.
- e. Power Supplies: DSX-1040PDP (power distribution panel) and DSX-1040CDM (communications distribution module), Included in 1048PKG.
 - 1) 10-15 VDC, 12 VDC nominal / 10A power for controllers. (Battery backed-up).
 - 2) 8-12 VDC 10A / 24 VDC 5.6A power for locks (optional battery backup).
 - 3) VDC .375 amp for 5-volt devices.
 - 4) UL 294 and UL 1076 compliant.
 - 5) AC loss and low battery supervisory outputs.
 - 6) Battery load test control input.
 - 7) Lock power override input.
 - 8) Provides individual fused outputs for 8 locks.
 - 9) Provides for 8 individual sets of termination of Lock wiring and control relay wiring. On removable terminals.
- f. Controller Architecture:
 - 1) RDC 186 20 MHz processor, RAM, ROM, and removable field wiring terminals.
- g. Compatibility:
 - 1) Controller is compatible with any identification device that transmits data using Wiegand, clock/data, or RS-232 ASCII at 1200 baud 8N1. This includes but is not limited to proximity, barium ferrite, bar code, magnetic stripe, Wiegand, keypads, and biometric readers.
- h. Memory:
 - 1) RAM: 512K
 - 2) ROM: 512K Flash
- i. Communications:
 - 1) Via direct serial port, dial-up modem, or TCP/IP. TCP/IP communications require additional hardware.
 - 2) Communication Ports: PC to controller 1 - RS-232 in; 50 feet max. 50 feet – 4,000 feet requires two MCI modules.
 - 3) Controller to controller in the same enclosure; RS232 via the 1040CDM. 1048 to 1048 regenerative RS485 4,000 feet max via the 1040CDM to other enclosures.
 - 4) 1040CDM (communications distribution module) handles RS232 between controllers in the same enclosure and serves as RS485 connection point for other 1040 Series PKG units or 1022 controllers in controller network.
- j. Physical Specifications:

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- 1) Cabinet: DSX-1040E 15.5 inches wide x 22.5 inches tall x 6 inches deep, key locale.
Total Weight: 25.0 lbs.
 - 2) Cabinet: DSX-1040PE 15.5 inches wide x 14 inches tall x 6 inches deep, key locale.
Total Weight: 25.0 lbs.
 - 3) Cabinet Finish: Black powder coat with white silkscreen.
 - 4) Operating Temperature: 32 to 131 degrees F.
 - 5) Operating Humidity: 0-95% RD
 - 6) Battery Charging Output:
Trickle Charge: 13.5 VDC. 500ma, fused.
- B. DSX-LAN Communications Interface with Modem Back-Up
1. Model DSX-LAN / DSX-LAN(M)
 - a. Contains both an RS-232 and RS-485 communication port for connection to any DSX Controller.
 - b. Auto-sensing for both 10 and 100 Mbit networks.
 - c. Auto-duplexing for compatibility with any router.
 - d. Power requirements of only 12 VDC @ 300ma, available from any DSX Controller.
 - e. Can be ordered with Dial-up (M)odem backup for redundant communications.
 - f. Can be programmed through a serial port using KB2CW.
- C. Quadraplexor:
1. Model DSX-1035 Quadraplexor Communications Multiplexer:
 - a. Multi-function, protocol independent communications repeater hub.
 - b. Accepts one RS-232 or RS-485 signal input and supplies one RS-232 signal output and four RS-485 signal outputs.
 - c. Complete with built-in power supply and battery charging circuit.
 - d. Use of device allows branch (star configuration) wiring.
- D. Open collector Output converter:
1. DSX-FRB8 8 Form C relay outputs:
 - a. Converts 8 open collector outputs to Form C relays rated at 5 amps.
 - b. Fuse in series with each common of each relay to protect relay and lock power supply.
 - c. Connects to 1048PKG or 1042PKG.
 - d. LED for each relay to show activation.
- E. Card Reader Cable Noise Filter Model DSX-220:
1. Designed for use in harsh environments where RF or electrical noise is induced on the cable.
 2. Serves as a data line extender for service up to 1500 feet from controller.
 3. Two-piece device, one each installed at controller and the other at the reader, (requires 12VDC power at controller and 12VAC at reader).
- F. Additional Controller Enclosure(s): DSX-1040E.
1. Six Slot Equipment Enclosure with Lock and Key. Accepts 4 1040 Series controllers, one 1040CDM and one expansion slot.
 2. Provided complete with wire channels, conduit knockouts, and wire tie anchors.
 3. Constructed of 18-gage powder coated steel, black color, with white silk-screened cabinet identifications.
 4. Depth: 6 inches deep.
 - a. Face dimensions: [15.75 inches wide x 22.75 inches high]
- G. Card Readers
1. HID multiCLASS Signo Model 20 or 40:
 - a. 13.56 MHz or 125 kHz Single Technology reader.
 - b. Readers shall be compatible with existing District Indala Proximity access cards.
 - c. Provide mullion size readers where required.
- H. Request to Exit Devices
1. Provide for all doors *where indicated on Drawings*.
 2. Tyco T.REX-LT, or equal:
 - a. PIR sensor technology
 - b. Suitable for wall or ceiling mounting

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- c. Two Form C output relays contacts
- d. LED indicator light
- e. Relay latch time adjustable to 60 seconds
- f. Programmable fail safe or fail secure modes.

(Addendum 4)

I. Door Release Pushbuttons

- 1. Door Release Console by ESI, or equal:
 - a. Momentary, SPDT, contacts rated 4 Amps at 28 VDC.
 - b. Plastic housing with mounting flanges, individual pushbuttons for remote door release and Lock-Down button (where applicable).
 - c. Pushbuttons protected by guard ring.

J. Panic Pushbutton Stations

- 1. *Panic Switch Pushbutton; GRI Series GR3045, or equal.*
- 2. *Provide where indicated on Drawings. Coordinate final locations with Owner prior to rough-in.*

(Addendum 4)

2.5 SYSTEM OPERATION AND CONTROL SPECIFICATIONS

A. System Integrity and Performance

- 1. Each controller shall operate as an autonomous intelligent processing unit. It shall be part of a fully distributed processing control network. Each controller shall maintain its own database, in its entirety, necessary for independent operation in its own RAM. It shall make all decisions about access control, alarm monitoring, linking functions and door locking schedules for its operation independent of any other system components.
- 2. When controller is brought on-line all database parameters shall be automatically downloaded to it. After initial download is completed only database changes shall be downloaded to each controller. This shall be referred to as "Incremental downloads" or "Downloading of Changes Only".
- 3. I/O Linking and Anti-Passback functions shall operate globally between all controllers within the same Location without any Host PC intervention. Linking and Anti-Passback functions shall not depend on any decision-making process or macros from the Host PC and shall occur even with the Host PC off line.
- 4. Controller operating system resides in Flash ROM that is upgradeable thru a download from the Host PC. Upgrades in controller operating system shall NOT require PROM changes.
- 5. A Location shall be defined as a loop of up to 64 controllers (128 devices).
- 6. The first controller of every Location shall be designated as the "Master". All subsequent controllers at the same Location shall be designated as "Slaves". Any controller may be selected by dipswitch settings to work as a Master controller. A Master controller shall perform all the same functions as a Slave controller, but it shall also be responsible for polling all Slave controllers and reporting the history transactions to the host PC. The Master controller shall not make any access decisions for the Slave controllers. The Master controller shall be the messenger for information from the controllers to the PC, and from the PC to the controllers.
- 7. Each card reader port of a controller shall be custom configurable for over 230 different card reader or keypad formats. Multiple card reader/keypad formats may be used simultaneously at different controllers and even within the same controller.
- 8. The Controller shall provide a response to all Card Read or Keypad entries in less than .25 seconds regardless of System size.
- 9. All valid codes for a Location shall be downloaded and reside in the controllers. The controllers shall not depend on querying the Host PC database or any other controller or system component for code authorizations.
- 10. All communication between the Host PC & Master controller (Direct, Dial-up or TCP/IP), and between the Master & Slave controllers use a polled communication protocol that checksum and acknowledges (ACK) each message. All communication is verified and will automatically be buffered and retransmitted if it fails to be acknowledged.
- 11. There shall be NO degradation of System performance in the event of a communication loss between the Host PC and the Master controller. The Master controller shall automatically switch to buffer mode storing up to 10,000 events. There shall be NO loss of transactions in System history files until the controller buffer overflows.
- 12. A missing or failed controller shall not degrade the performance of the communicating controllers in the controller communication network. Missing controllers shall be ignored and sampled less often

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- by the Master controller. Any functioning Slave controller not communicating with the Master will automatically switch to buffer mode storing up to 10,000 events.
13. Buffered events shall be handled in a FIFO (First in First Out) mode of operation.
 14. All controllers shall have a built-in dead man reset timer (watchdog circuit) that automatically reboots the controller in the event the processor is interrupted for any reason.
 15. Any controller that is reset or powered up from a non-powered state shall automatically request a parameter download and reboot to its proper working state. This shall happen without any operator intervention.
 16. The System shall provide a means for viewing the Communications Status of the intelligent controllers RS485 Communications loop.
 17. The Communication Status window shall display which controllers are currently communicating, a total count of missed polls since midnight, and which intelligent controller last missed a poll. Missed polls reflect that messages had to be retransmitted and are an indication to the soundness or quality of the controller-to-controller network.
 18. The Communication Status window shall show what type of CPU, what type of Input/Output board, and how much RAM Memory each controller has.
 19. The chance that a controller will allow access to an unauthorized individual under normal operating conditions shall be less than 1 in 10,000.
 20. The chance that an authorized individual will be denied access under normal operating conditions shall be less than 1 in 1,000.
- B. PC to Controller Communications (All Types)
1. The System shall communicate using Serial ports for direct connections, and/or TCP/IP LAN and/or dial-up Modems for connections to Locations.
 2. The System shall be able to use either one or both serial ports for dial-up modems, and either one or both serial ports for direct connect Locations and/or TCP/IP LAN connect Locations.
 3. The serial ports used for communications shall be individually configurable for Direct Communications, Modem Communications Incoming & Outgoing, or Modem Communications Incoming only, or as an ASCII output port.
 4. If more than 2 serial ports are needed, a Windows compatible Multi-Port Communications Board shall be used.
 - a. The outboard multi-port serial board shall connect to an internal PCI bus adapter card. The port expander boards shall have an expandable and modular design. The port expansion modules shall be available in a 4, 8, or 16 Serial Port Configuration that is expandable to 32 or 64 serial ports.
 - b. The Multi-Port Comm. Board shall allow multiple direct connect Masters to be connected to the System.
 - c. the Multi-Port Comm. Board shall allow multiple dial-up modems to be connected to the System.
 5. Direct serial, TCP/IP and Dial-up Modem Communications shall have no difference in monitoring or control of the System with the exception of the connection that must first be made to a dial-up Location.
 6. For TCP/IP communications an option to set the Poll Frequency and Message Response Time Out settings shall be available. This will allow tuning for bandwidth and latency issues associated with network communications.
- C. Direct Serial or TCP/IP PC to Controller Communications
1. The communication software on the PC shall supervise the Controller to PC Communications link.
 2. The communications shall be supervised when using either direct serial port connections, or TCP/IP LAN connections.
 3. Loss of communications to any Master Controller shall result in a Communication loss alarm at all PCs running the communications software. The Master controller shall then automatically buffer events.
 4. When communications are restored to the Master Controller all buffered events shall automatically upload to the PC and any database changes shall automatically be sent to the Master controller.
- D. D. Dial-up Modem PC to Controller Communications
1. The communication software on the PC shall supervise the Controller to PC Communications link during dial-up modem connect times.
 2. The System shall be programmable to routinely poll each of the remote dial-up modem Locations collecting event logs and verifying phone lines each at different time intervals.

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3. The System shall be programmable to dial and connect to all dial-up modem Locations and retrieve the accrued history transactions on an automatic basis as often as once every 10 minutes to once every 9999 minutes.
 4. Failure to Communicate to a dial-up Location 3 times in a row shall result in an alarm at the PC.
 5. Time offset capabilities shall be present so that Locations in a different geographical time zone than the Host PC will be set to and maintained at the proper local time. This feature shall allow for geographical time zones that are ahead or behind the host PC.
 6. The Master of a dial-up modem-connected Location shall automatically buffer all normal transactions until its buffer reaches 80% of capacity. When the transaction buffer reaches 80% the Master controller shall automatically initiate a phone call to the central monitoring PC and upload all transactions.
 7. If an alarm event occurs, the Master controller shall initiate an immediate call to the PC to report the alarm event.
 8. Modem Communications shall allow the use of 9600-baud dial-up modems provided by the manufacture of the System. Modems used at the Master Controller shall be powered and battery backed up by the controller.
- E. Controller to Controller Communications
1. The Controller to Controller Communications shall be a true RS-485, 4-wire, point to point, regenerative (repeater) communications network methodology.
 2. The RS-485 communications signal shall be re-generated at each controller without any additional modules or hardware.
 3. The controller-to-controller communications shall be performed without the use of external modules or devices.
 4. The Master Controller shall supervise the communications to each Slave controller. Communication Loss shall be reported immediately for direct serial port connected Locations. Controller communications loss shall be configurable to initiate a call to the PC for dial-up modem Locations.
- F. Database Downloads
1. Controllers shall initially be downloaded with all Location data.
 2. The System shall download all database changes to the intelligent controllers utilizing automatic non-invasive incremental updates also known as the Downloading of Changes Only.
 3. When data is downloaded from the PC to the Master controller the PC shall request a complete database checksum to check the integrity of the download. If the data checksum does not match the PC, the full data download shall automatically be retransmitted to the Master controller.
 4. When data is downloaded from the Master controller to a Slave controller the Master controller shall request a complete database checksum to check the integrity of the download. If the data checksum does not match the Master, the full data download shall automatically be retransmitted to the Slave controller.
 5. When data is transferred from the Master controller to the Slave controllers the integrity of the data download is verified through checksums. A check sum on each message, each table, and a final table total checksum are calculated. If the checksums do not match the Masters the data shall be automatically retransmitted from the Master to Slave.
 6. If the Master controller is reset for any reason, it shall automatically request a database parameter download from the PC. When the Master is a dial-up modem connect Location, it shall automatically dial the PC, and request and receive the database parameter download. The download shall restore the remote site to its normal working state and shall take place with no operator intervention.
 7. Slave controllers that have lost communication with the Master controller upon restoral shall have their database evaluated by the Master Controller. If the controllers' database is still current the controller is brought back on-line without downloading. If the controllers' database is not current it is brought back on-line and then fully downloaded. This download shall restore the Slave controller to its normal working state and shall take place with no operator intervention.
 8. When changes are made to the database for a dial-up modem Location the PC shall automatically call and download those changes to that Location. No operator commands shall be necessary.
 9. The System shall have the ability to schedule the download of changed data to a dial-up Location (for lower phone rates) between the hours of 2 and 5 AM.
 10. The System shall also allow the data changes to be downloaded immediately or after a programmable delay from 1-999 minutes (prevents system from multiple sequential phone calls when editing a dial-up Locations' data).
- G. Alarm Response and Handling
1. The System shall have manual and automatic responses to incoming point status change or alarms.

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2. Each input shall have the ability to respond automatically with a link to inputs and or outputs, operator response plans, unique sound with the use of WAV files, maps or images that graphically represent the point Location.
 3. Maps shall automatically display for each input assigned to it that has gone into alarm if the option is selected on a per input basis.
 4. Alarm handling shall require a two-step process. When the alarm is first responded to it will be referred to as Acknowledged. This shall silence alarm beeping and any alarm WAV files being played. The alarm is then referred to as acknowledged but Un-Resolved. The next handling of the alarm will give the operator the ability to give a resolution (or operator comment) as to the final disposition of the event. The alarm shall then clear.
 5. Each workstation shall display the total pending alarms and total un-resolved alarms.
 6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
 7. Alarms shall be reported in a real time fashion barring any connection time for non-direct connect (dial-up) Locations to the Host PC where the operator shall be alerted and given an optional response plan or Action Message.
 8. Operator response action messages shall be a minimum of 65,000 characters each with up to 32,000 messages.
 9. Alarms shall be displayed and can be handled from a minimum of 4 different windows.
 - a. The input status window: The status Icon will be overlaid with a large red blinking Icon. Selecting the Icon will acknowledge the alarm.
 - b. The History log transaction window: The name, time, and date will display in red text. Selecting the red text will acknowledge the alarm.
 - c. The Alarm log transaction window: The name, time, and date will display in red verbose. Selecting the red text will acknowledge the alarm.
 - d. The graphic map display: The Icon for the input in alarm will flash with a large red blinking Icon. Selecting the Icon will acknowledge the alarm
 10. Once the operator has acknowledged the alarm, they shall be automatically prompted to enter comments as to the nature of, and action taken on the alarm. The operator comments may be manually entered or selected from a predefined list or a combination of both.
 11. Predefined Operator Comments shall have the ability to be used to resolve alarms where there are regular alarm occurrences. The operator shall have the means to choose from a list instead of typing the same message repeatedly.
 12. The System shall track when and who acknowledged and resolved the alarm.
 13. All identical alarms (from the same alarm point) shall be acknowledged at the same time the operator acknowledges the first one. All identical alarms shall be resolved when the first alarm is resolved. Restoral conditions, if set to be acknowledged shall follow the same operation as just described above for alarms.
 14. The user shall have the ability to manually command inputs to arm, bypass, or follow their Time Zone from the PC with a one-step command.
 15. The System shall have an alarm popup message window and beep that informs the operator of an alarm that is pending. This shall occur even when the alarm monitoring application is not the top window.
 16. The alarm popup message window shall display the alarm and precisely identify the point.
 17. The popup alarm window shall also provide the operator the opportunity to ignore the alarm and clear the popup window or to jump to the alarm-handling window and deal with the alarm and any subsequent alarms.
 18. Alarm Messages shall be receivable by the PC even when the PC is downloading or retrieving a Log from the Location Master.
 19. The System shall have the ability to acknowledge and resolve alarms and control inputs and outputs during a download and Log retrieval.
 20. When a reader-controlled output (relay) is opened the corresponding alarm point will automatically be bypassed.
 21. All alarm points located on System controllers, with the exception of the 1043, shall accommodate 2, 3, and 4-state point monitoring with trouble conditions.
 22. All inputs, with the exception of the 1043 shall be individually programmable with at least 5 different circuit types to choose from.
- H. Input and Output Control
1. All inputs in the System shall have two Icons representations, one for the normal state and one for the abnormal state.

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2. When viewing and controlling inputs the Icons shall respond by changing and updating to the proper Icon to display that input's current state in real time. These Icons shall also display the inputs armed or bypassed state, and whether the input is in the armed or bypassed state due to a time zone or by a manual command.
 3. All outputs in the System shall have two Icon representations, one for the secure (locked) state and one for the open (unlocked) state.
 4. When viewing and controlling outputs the Icons shall respond by changing and updating to the proper Icon for that points current state in real time. These Icons shall also display whether the output is in the secured or open state due to a time zone or by a manual command.
 5. Animation: The Icons used to display status of the Input or Output points shall be constantly updated without any prompting by the operator to show their current real time condition.
 6. The operator shall be able to scroll the list of Inputs or Outputs and press the appropriate button on toolbar or right click to perform the desired function: arm, bypass or set to time zone for inputs, and secure, open, or set to time zone for outputs.
 7. Graphic Maps containing Inputs, Outputs and Override groups:
 - a. Full color Maps shall be importable from most any graphics file format. Maps shall allow for all input, output, and override group Icons to be placed on the maps in an easy one step drag and drop method.
 - b. Maps shall provide real-time display animation and allow for control of all points assigned to it.
 - c. The System shall allow the same inputs, outputs, and override groups to be defined on different maps. There shall also be the ability to navigate from one map to the next that the points are defined on. There shall also reside the ability to order or prioritize the order in which the Maps will be displayed.
 8. Override Groups containing Inputs and Outputs:
 - a. The System shall incorporate override groups that provide the operator with the status and control over user defined "sets" of inputs and outputs with a single Icon.
 - b. The Icon shall change automatically to show the live summary status of all points in that group.
 - c. The Override Group Icon shall provide a method to manually control or set to time zone all points in the group.
 - d. The Override Group Icon shall allow the expanding of the group to show the Icons representing the live status for each point in the group, individual control over each point and the ability to compress the individual Icons back into one summary Icon.
 9. Schedule Overrides of Inputs, Outputs and Override Groups:
 - a. To accommodate temporary schedule changes that do not fall within the holiday parameters the system shall incorporate scheduled overrides individually for each input, output, and override group in the System.
 - b. Each schedule shall be comprised of a minimum of two dates with separate times for each date.
 - c. The first time and date shall be assigned the Override State the point shall advance to, when the time and date become current.
 - d. The second time and date shall be assigned the state in which the point shall return to, when that time and date becomes current.
- I. I/O Linking
1. The System shall support I/O Linking, which is an action initiated by an input, output, or card read that causes a reaction within a group of inputs and/or outputs. Linking to an input controls its armed state. Linking to an output controls it's on/off state.
 2. In regard to the before mentioned Linking characteristics the System shall fully facilitate Input to Input Linking, Input to Output Linking, Output to Output Linking, Output to Input Linking, Code to Input, and Code to Output Linking.
 3. All Input, Output, and Code Linking shall operate on a global level within a Location. Global linking is any input, output, or card read use can initiate a link from any controller in the Location to any inputs and/or outputs on any controller(s) within the same Location without any interaction with the host PC.
 4. The System shall provide Linking initiated by an input change of state or an input alarm.
 5. The System shall provide Linking initiated by the transition of an output from secure to open and the transition from open to secure.
 6. Code to input and/or output linking shall be initiated by a designated code used at a designated reader/keypad.
 7. The reader/keypad used will determine which group of inputs and/or outputs will be activated. That is the same card can cause a different link to occur based on which reader the card was read at.
 8. Responses to links shall include follow, latch, pulse, toggle, and return to time zone.

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9. In addition to inputs and outputs, time zones shall also have the ability to receive a link from an input, output, or card read. Within each time zone definition, there shall be the option for the time zone to be "On" or "Off" when a link is received.

J. LAN Installations

1. The Local Area Network shall allow multi-user capabilities to the system. It shall allow all functions to be executed at every Workstation on the LAN running the WinDSX software.
2. The software, running on a LAN, shall support as few as 2 Workstations or as many as 1000.
3. The System software shall be Local Area Network (LAN) compatible without any software supplements or upgrades.
4. The system shall be compatible with Windows XP Pro Svc Pack 2, Windows Vista Business Svc Pack 1, Windows 7 Pro 32/64 bit, Windows 8 Pro 32/64 bit.
5. The system shall utilize TCP/IP as the primary protocol.
6. The software shall be installed on the local hard disk of each Workstation so that each Workstation shall run the executable files of the program from the local hard disk but reference the shared database on the File Server.
7. One PC shall be designated as the Comm. Server. This PC shall have the actual physical connection to the Intelligent Controllers by way of Direct Serial Port Connection, Dial-Up Phone Modem, or TCP/IP.
8. All Workstations shall have full control capabilities over the controllers. They shall be able to perform all administrative duties such as Reports and Database Management and interact with a local or remote site as operator password privileges allow.

2.6 DATA BASE AND SYSTEM FEATURE SPECIFICATIONS

A. Database Operation

1. The System data management program general layout shall be in a hierarchical menu tree format with simple navigation through expandable menu branches and manipulated with the use of menus and Icons in a main menu and System toolbar.
2. The System shall use standard Icons in the toolbar for Add, Delete, Copy, Print, Capture Image, Activate, Deactivate, and Who-Is-In (Muster) report.
3. The System shall be programmable with English prompts, scrollable menus, and pull-down windows.
4. All data entry shall automatically be checked for duplicate and illegal data. This field verification shall be used to insure proper information is entered into the System.
5. The Database Management Program shall provide a Point and Click approach to data manipulation.
6. Upon making a selection in database, the view window shall immediately display a list of records for the selected topic. From the view window Add, Edit, or Delete commands may be selected. The process of adding, editing or deleting will then return operator to the View Mode giving immediate visual feedback to all the program entries, existing or those just changed.
7. There shall be a memo or note field for each item that is stored in the data. These note fields are useful for storing information about any defining characteristics of the item. These could be but are not limited to; the Location of, what purpose item was entered for, or reasons changes were made.
8. There shall be a next and previous command buttons visible when editing any database field for quickly navigating from one record to the next.
9. There shall be a copy command and copy tool in the tool bar to copy data from one record for the purpose of creating a new similar record.
10. The system shall check all database entries for valid data and shall automatically display an error describing any invalid data.

B. File Management

1. The operator shall be able to backup the System data at any time and may define that backups be performed unattended.
2. The Backup program shall be an integral part of the access control software. The backup System shall be easy to use with menu guidance.
3. The System shall incorporate an Integral Database Backup and Restoration System with selectable target media including any Windows logical drive, Zip drives, and network resources as a minimum.
4. The System Backup feature shall have both a Manual and Automatic mode of operation.
5. The System shall incorporate a Manual and Auto-Backup History feature that allows history to be backed up to a specified target and storage media including Windows compatible logical drives, Zip drives, and network resources as a minimum.
6. The System shall incorporate database restoration features that allow data to be selectively restored.

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7. The backup program shall provide manual operation from any PC on the LAN and shall operate while the system remains operational.
- C. Operator Passwords
1. The software shall support up to 32,000 individual operators each with a unique password.
 2. Each password shall be from 6 to 10 alphanumeric characters.
 3. Passwords shall be capable of being case sensitive.
 4. The password shall be hidden and never displayed when entered.
 5. Each password shall accept a unique and customizable password profile with the ability for several operators to share a password profile.
 6. There shall be 32,000 definable operator password profiles.
 7. One password profile shall be predetermined for access to all functions and areas of the program.
 8. Each password profile may be customized to allow or disallow operator access to any program operation.
 9. All software functions shall have the ability to restrict operators through settings in a password profile.
 10. All database functions such as View, Add, Edit, and Delete shall have the ability to restrict operators by settings in a password profile.
 11. Password restriction shall apply to each input and output individually. This restriction specifies which inputs and outputs the operator is able to manually manipulate.
 12. Password shall be able to restrict which doors an operator can assign access to.
 13. Operators shall use a User Name and Password to log on the System.
 14. The same User Name and Password is used to access all areas and all programs.
 15. Once logged on, only those menu items and functions that the operator is authorized for based on the operator's password profile are displayed.
 16. There shall be an icon that allows the operator to log off without fully exiting the program. User may be logged off but the program will remain running. The logon window shall then be displayed for the next operator.
 17. The system shall have the ability to hide the user name of the previous operator logged on.
 18. Where "Strong or Complex" password utilization is required WinDSX SQL can use Active Directory to authenticate operators. Once allowed in by AD the operator is still controlled by their password profile.
- D. Hardware Location Password
1. There shall be a Location password that will be utilized for PC to Dial-up Modem sites to prevent unauthorized communications with the Location.
 2. Each Location password shall be from 1 to 8 alphanumeric characters.
 - a. The Location Password shall be verified with the dial-up Location Master controller before communication proceeds.
- E. Reports and History
1. All history shall be initially stored on the hard disk of the host PC.
 2. The system shall have the ability to view the History on any workstation or print History to any system printer.
 3. All History Reports shall allow the user to select any date, time, event type, device, output, input, operator, Location, name, or cardholders to be included or excluded from the report.
 4. The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.
 5. Each report shall depict the date, time, event type, event description, device, or input/output name, cardholder company assignment, and the cardholder name or code number.
 6. Each line of a printed report shall be numbered to insure the integrity of the report has not been compromised.
 7. The total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms" the total shall reflect how many alarms occurred during that period.
 8. All reports shall have the 3 following options:
 - a. View on Screen.
 - b. Print to System Printer.
 - c. Save to File with full path statement.
 9. The System shall have the ability to produce a report indicating either:
 - a. The status of the Systems inputs and outputs.
 - b. The inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.

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10. The System shall facilitate a Custom Code List Engine which allows the Access Codes of the System to be sorted and printed according to the following criteria:
 - a. Active, Inactive, or Future Activate or De-activate
 - b. Code number, Name, or Imprinted Card Number
 - c. Company, Location, Access Levels
 - d. Start and Stop Code Range
 - e. Codes that have not been used since X number of days
 - f. In, Out, or Either status
 - g. Codes with Trace Designation
 11. The System shall incorporate a Who Is In (Muster) report; One Button Report for cardholder locating. This report shall contain a count of all persons that are "In", Location wide, and a count with detailed listing of name, date and time of last use, grouped by the last reader used or by the company assignment. This report shall also be generated from a pre-defined alarm input. Any Workstation in the system shall be able to print the report for a particular Location.
 12. The reports of the systems database shall allow options such that every data field may be printed.
 13. The reports of the systems database shall be constructed such that the actual position of the printed data shall closely match the position of the data on the data entry windows.
- F. Graphics:
1. The software shall support 32,000 Graphic Display Maps. The system shall allow the maps to be imported from a minimum of 21 standard formats from another draw or graphics program including AutoCad TM.
 2. All Inputs and Outputs shall have the ability to be placed on any graphic map in a drag and drop method.
 3. Graphic maps shall display automatically the real time state of outputs and inputs in an animated fashion.
 4. Camera Icons shall have the ability to be placed on any graphic map that when selected will open a live video window and display the camera associated with that Icon and provide for real time Pan/Tilt/Zoom control.
 5. Any Input, Output or Camera placed on a map shall allow the ability to Arm or Bypass an input, Open or Secure an output, or control the Pan/Tilt/Zoom function of any camera.
 6. Any alarm input activation shall optionally by input automatically pull up a graphic map associated with the alarm.
 7. Any alarm activation shall give the operator the ability to manually pull up a graphic map associated with the alarm.
 8. The operator shall be able to view the inputs or outputs and the point's name by simply moving the mouse cursor over the point on any graphic map.
 9. All inputs and outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view all Graphic Maps associated with any input or output.
 10. Each graphic map shall have a display order sequence number associated with it to provide a predetermined order when toggled to different views.
 11. Map size shall be configurable for each map.
- G. Help:
1. All main menus shall have a Help option listed.
 2. The System Help selection shall provide a unique and descriptive context sensitive Help System for all selections and functions with the press of one function key.
 3. The Help System shall provide a manner of navigation to any specific topic from within the first Help window.
 4. The help system shall be accessible outside the program.
- H. Access Card/Code Operation and Management:
1. Access authorization shall support verification of the card/code by facility code (if implemented) first, by card/code and/or Pin validation second, by access level (time of day, day of week, date), by anti-Passback status, and by number of uses.
 2. The System shall allow multiple cards/codes to be assigned to a cardholder.
 3. Each card/code assigned to a cardholder shall have the ability for an unlimited number of access levels assigned to it across all Locations. Each access level shall have any combination of doors in it. Each door shall have the ability to have 4 time zones associated with it.
 4. The System shall allow the grouping of Locations that allows cardholder data to be shared by all Locations in the group, thus preventing the redundant data entry.

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5. The System shall facilitate the viewing, building, editing and issuing of access levels from the code entry window, through an Access Level Manager Engine that maintains and coordinates all access levels to prevent duplication or the incorrect building of levels.
 6. The System shall allow a person to be entered into the System for visitor, data tracking or photo ID purposes without assigning that person a card or code.
 7. Key Tracking shall be an integral function of Cardholder data. This shall allow the tracking and accountability of lock hardware keys (metal keys) issued to each cardholder. Reports can be generated displaying all keys assigned to this cardholder or all cardholders that have a specific key.
 8. The System shall provide a special audible and visual annunciation at the PC when a card/code selected to be traced is used at designated trace readers. In addition, cardholder image shall be automatically displayed when a traced card is used at designated trace readers.
 9. The System shall allow each Card Holder to be given either an unlimited number of uses or a number range from 1-9998 that regulates the number of times the card can be used before it is automatically disabled.
 10. The System shall allow cards/codes to be activated and de-activated manually or automatically by date as well as time. The System shall allow for multiple de-activate dates to be pre-programmed.
 11. The System shall have the ability to de-activate cards/codes by company based on lack of use for a pre-defined number of days.
 12. Integral Photo ID Badging and Photo Verification shall use the same database as the Access Control System and may query data from cardholder, company, and other personal information to build a custom ID badge.
 13. Automatic or manual image recall and manual access based on photo verification shall also be a means of access verification and entry.
 14. The System shall allow a means of grouping cardholders together by Company (department) or other characteristic for a more efficient method of reporting on and enabling/disabling cards/codes.
 15. The Access Codes may be up to 12 digits in length.
- I. Facility Codes
1. The System shall accommodate up to 2048 Facility Codes per Location with the option of allowing the Facility Codes to work at all doors or just particular doors.
- J. Operator Comments
1. With the press of one appropriate button on the toolbar the user shall be permitted to make Operator Comments into History at any time.
 2. Automatic prompting of Operator comment shall occur before the resolution of each alarm.
 3. Operator Comments shall be recorded with time, date, and operator number.
 4. Comments shall be sorted and viewed through Reports and History.
 5. The operator comments shall comprise of two parts and either or both may be utilized, predefined or manually entered.
 - a. Manually entered through keyboard data entry (typed) up to 65,000 characters per each alarm.
 - b. Predefined and stored in the database for retrieval upon request.
 6. The system shall have a minimum of 999 Predefined Operator Comments with up to 30 characters per comment. The Operator Comments that can be manually entered shall accept up to 65,000 characters per Comment.
 7. Predefined Operator Comments shall have the ability to be used to resolve alarms where there are regular alarm occurrences. The operator shall have the means to choose from a list instead of typing the same message repeatedly.
- K. Company
1. The System shall provide a means of assigning one of 32,000 company names to a group of cardholders.
 2. Company names may be used to separate cardholders into groups that allow the operator to determine the tenant, vendor, contractor, department, or division of a company the person belongs.
 3. The software shall have the ability to deactivate and re-activate all codes assigned to a particular company with one action.
 4. History reports and code list printouts shall have provisions to be sorted by Company name.
 5. Company names shall provide a means to give managers reports that pertain to their personnel only.
- L. Time Zones
1. The System shall allow up to 32,000 Time Zones for each of the 32,000 Locations.

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2. Each Time Zone shall contain a start and stop time for 7 the days of the week and 3 separate holiday schedules.
 3. A Time Zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm/disarm, when an output shall automatically open/secure, or when cards assigned to an access level shall be denied or granted access.
 4. Dynamically linked bar graphs shall display the resultant active and inactive times for each day and holiday as start and stop times are entered or edited.
 5. The System shall allow for up to 4 different Time Zones to be assigned to any input, output.
- M. Holidays
1. The System shall have provisions for 32,000 Holidays.
 2. Each Holiday shall be defined with MM/DD/YYYY and a description.
 3. Up to 32,000 holidays may be entered in advance.
 4. Holidays shall be defined as a minimum of three types. This will allow for 3 separate holiday schedules.
 5. Holidays shall have an option to be designated as occurrence each year, those shall remain in system and not be purged.
 6. Holidays not designated to occur each year shall be automatically purged from the database after the date expires and a new Holiday is added.
 7. Each Holiday shall have the ability to be assigned to one of three types of Holiday. The type of holiday shall be relative to a time period of one (24) hour period.
 8. Holidays may be created per Location or by Location Group.
- N. Access Levels
1. The System shall allow for 32,000 access levels.
 2. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times.
 3. The System shall allow for access to be restricted to any area by reader and by time. Access Levels shall determine when and where a card is authorized.
 4. The System shall be able to create multiple door and time zone combinations under the same Access Level so that a card may be valid during different time periods at different readers even if the readers are on the same controller.
 5. Each door in an access level shall have the ability to have a minimum of 4 different time zones assigned to it.
 6. The System shall incorporate an Access Level Manager Engine for menu guidance and assistance in creating, managing, and assigning access levels.
 7. The manager shall be accessible from the card data entry window.
 8. When assigning an Access Level, the access level manager engine shall provide door and time zone listings for the operator to choose from.
 9. The system shall allow for the ability to copy form one door assignment up to 4 time zone schedules with one operation for assignment to another door. This shall reduce operator data entry time when creating access levels that use like time zone schedules.
 10. The system shall allow the User to Modify Access Levels in Bulk by first selecting multiple cardholders to be modified.
- O. User Defined Fields
1. The System shall provide a minimum of 99 User Defined Fields for specific information about each access code holder.
 2. User defined fields shall allow up to 50 characters per field.
 3. The title of each field shall be programmable up to 20 characters.
 4. There shall be a "Required" option for each user defined field that when selected forces the user to enter data in the user-defined field before the cardholder record can be saved.
 5. There shall be a "Unique" option for each user defined field that when selected will not allow duplicate data from different cardholders to be entered.
 6. There shall be a "UDF Data is Hidden" option for each user defined field that will require any given operator to have that option available in his/her password profile before that hidden data can be viewed.
 7. Each User defined field shall have data masking in its setup that will require the data to be entered with certain character types in specific spots in the field entry window. This shall facilitate data to have like formatting display.
 8. There shall be an option for each user defined field when selected will define the field as a deactivate date. The selection shall automatically cause the data mask to be formatted with the windows short

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- date format. The system will order these fields and use the next future date of that order to set the deactivate date of that cardholder.
9. There shall be an option to select one of the 99 user defined fields as the Name ID. Data from this type of user-defined field will appear on the same window as the cardholder data entry window.
 10. There shall be a search capability to allow any one user defined field or combination of user defined fields to be searched to find the appropriate cardholder.
 11. String searches shall have the ability to be made on any field in conjunction with any other field searches.
 12. The System shall have the ability to print cardholders based on and organized by the Used Defined Fields.
- P. Code Tracing
1. The System shall perform Code Tracing selectable by cardholder and by reader.
 2. Any code may be designated as a Traced Code with no limit to how many codes can be traced.
 3. Any reader may be designated as a Trace Reader with no limit to which or how many readers can be used for Code Tracing.
 4. When a Traced Code is used at a Trace Reader the Access Granted Message that usually appears on the Monitor window shall be highlighted with a different color than regular messages.
 5. A short singular beep shall occur at the same time the highlighted message is displayed on the window.
 6. The traced cardholder image (if image exists) shall appear on workstations when used at a trace reader.
- Q. Visitor Assignment
1. The system shall have a means of allowing cardholders to be assigned with a visitor designation.
 2. The system shall allow Names to be added that may or may not be assigned codes.
 3. The system shall be able to restrict the access levels that may be assigned to cards that are issued to visitors.
 4. There shall be an option on access levels that will designate an access level as visitor assignable.
 5. The system shall utilize an online log book that during enrollment of a visitor the operator will have access to a search engine that will produce a view all names in the query and by point and click method enter the name of whom is being visited.
 6. The system shall create an event for the history transaction as to the date time the visitor was added and to whom they were to visit.
 7. Once a visitor is enrolled in the system upon the next visit the system shall allow the operator to recall that visitors' cardholder file and by utilizing the search engine query, point and click on the name of the person being visited on this occasion. The system shall create a transaction with visitors' name and whom they were to visit on that date.
 8. The system shall allow designation of any reader as one that deactivates the card after use at that reader, and logs to history as the return of the card.
 9. The system shall have the ability to utilize the visitor designation in searches and reports. Reports shall be able to print all or any visitor activity.
- R. Live Video and Camera Control
1. The system shall provide means of displaying in a separate window the live video from a CCTV source.
 2. The display window shall have separate control buttons to represent Left, Right, Up, Down, Zoom In, Zoom Out, Scan and minimum of two custom command auxiliary controls.
 3. The command structure shall be such that one command string shall be issued when the control button is pressed down and another command shall be sent when the button is released. There shall be an option to automatically repeat the pressed down command as long as the button is pressed.
 4. An Icon shall represent each camera to be controlled. Standard mouse clicking shall open a window that will display the video. If the system is connected to a video switcher it shall automatically send a command through a comm. port to display the requested camera when the Icon is selected.
 5. The system shall provide a minimum of 7 Icons to represent different types of cameras. The ability to import custom Icons shall be provided.
 6. The Icons shall be able to be placed on graphic maps to represent their physical Location. Standard mouse clicking shall open the display window for selected camera.
 7. Each camera shall provide the ability to display and control a specific output on the video display window. The Icon representing the output shall display its real time status and respond in an animated fashion to the data reported from the field controller.

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8. Each Input and Output shall be definable as associated with a camera. Upon selecting an Input or an output the system shall provide a pop-up option window that will allow the camera associated with the point to be displayed.
9. The alarm-handling window shall have a command button that will allow the display of the camera associated with the alarm point.
10. The CCTV video shall be brought into a "Video Capture Card" installed on the PC where video is desired.
11. The system shall have a Next and Previous command buttons on the display window that when selected will allow the user to scroll through all cameras defined on a workstation.
12. The system shall provide that the same camera may be defined several times but display a different controlled Icon. This shall be used when one camera can view several entrances and will facilitate the use of the Next, Previous buttons.

2.7 SYSTEM WIRING

- A. Manufacturers
 1. Commscope
 2. Belden
 3. West Penn
- B. Wiring type and size shall be as recommended by the manufacturer.
- C. All wiring shall be plenum rated.

2.8 INTRUSION DETECTION INTERFACE

- A. Provide equipment and programming as required to interface the Intrusion Detection system specified in section 281600.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Install system components and appurtenances in accordance with the printed instructions.
- B. Provide all necessary interconnections, services, and adjustments required for a complete and operable system.
- C. Install control signal, communications, and data transmission line grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

3.2 WIRING METHODS

- A. Wire Routing: Route all device wiring from each device up into ceiling cavity within metallic conduit in recessed or unfinished areas or within surface raceway for renovated non-fishable areas. Stub all conduits into ceiling cavity and provide protective bushing for each.
- B. Cable Routing: Route cable for all device wiring within accessible ceiling cavities. Install in bridle rings at 4' spacing maximum. No cabling is to lie on or attach to ceiling tile, ducts, pipes, conduits or ceiling suspension wires, rods, or structural members. Provide conduit stubs from devices and panels to the ceiling cavities.
- C. Route all fire alarm wiring from fire alarm panel within metallic conduit up into nearby ceiling cavity and connect to the wiring system indicated in A and B above. Provide bushings at conduit ends.
- D. Provide raceways for cabling in all open structure spaces.

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3.3 FIELD QUALITY CONTROL

- A. Testing:
 - 1. Supply a proposed acceptance test procedure.
 - 2. Testing of system shall be the sole responsibility of the Contractor.
 - 3. Communications tests:
 - a. Controllers to manager server.
 - b. Manager server to client.
 - c. Remote dial-up support.
- B. Inspection:
 - 1. Provide an on-sight, factory-trained technician to assist, advise or manage installing personnel.
 - 2. All final connections shall be made under the direct supervision of the Systems Integrator.
- C. Field Service:
 - 1. Provide first line support for both the hardware and software properties of the selected system.
 - 2. Provided second line support directly from the manufacturer for all component and computer hardware and all operating and application software that comprise the complete system.
 - 3. Determine and report all problems to the manufacturer's customer service departments.
 - 4. Support shall be available to the integrator via the following methods:
 - a. Phone inquiries.
 - b. Direct dial-in to the customer system for remote system troubleshooting by a qualified Field Service Engineer.
 - c. On-site visits if required, upon approval by the manufacturer's Customer Service Manager.

3.4 ON-SITE COMMISSIONING AND TRAINING

- A. The installing company shall provide direct participation in the on-site commissioning activity of new systems. Not less than 16 hours of on-site training shall be provided for a maximum of 6 representatives of Owner.
- B. Provide systems administrator that is factory trained with the expertise on installing, configuring and commissioning the system to the customer's specific requirements; and to provide on-site training on system operation and administration.
- C. On-site shall be available for system administrators, Operators and other qualified personnel.
- D. On site commissioning shall include:
 - 1. Hardware set-up and testing.
 - 2. Preventative maintenance and troubleshooting training.
 - 3. End User training.
 - 4. Database configuration and build assistance.

3.5 FINAL ACCEPTANCE

- A. Perform the following performance standards before final acceptance:
 - 1. Operate all mechanical devices without down time for a period of 10 days
 - 2. Operate all electronic devices and equipment without downtime or programming problems for a period of 30 days.

Upon completion of system testing and before the acceptance cycle, provide 2 copies of system manual to Owner.

END OF SECTION 28 10 00

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SECTION 282300 – VIDEO SURVEILLANCE SYSTEM CABLING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide cabling for future cameras installed by the Owner.

PART 2 - PRODUCTS

2.1 CABLES

- A. Provide UTP cables as specified in Division 27 from Camera to network racks in IDF/MDF Rooms.
- B. UTP cables for cameras shall be a different color than the UTP data cables.

2.2 PATCH PANELS

- A. Provide UTP rack mounted patch panels as specified in Division 27. Camera patch panels shall be installed in the network racks in IDF/MDF Rooms.
- B. Provide patch cables as specified in Division 27. Provide lengths as needed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Category 6 installation shall meet all requirements of Division 27.
- B. Interior Cameras: Provide (1) Category 6 cable to nearest IDF/MDF with connections on each end. Refer to Detail on the Drawings.
- C. Exterior Cameras: Provide (1) Category 6 cable to nearest IDF/MDF with connections on each end. Refer to Detail on the Drawings.
- D. Provide 15' of extra cable at each camera locations for flexibility in installing cameras.
- E. Provide 1" conduit from each camera to nearest accessible corridor.

END OF SECTION 282300

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SECTION 283111 – DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire Alarm Control Equipment
- B. Manual Initiating Devices
- C. Automatic Initiating Devices
- D. Notification Appliances
- E. Fire Alarm Interface Modules

1.2 RELATED WORK/DIVISIONS

- A. Division 1
- B. Division 8
- C. Division 23

1.3 REFERENCES

- A. Pennsylvania Construction Code Act (Title 34)
- B. International Building Code
- C. NFPA 70 - National Electric Code as adopted by IBC
- D. NFPA 72 – National Fire Alarm Code as adopted by IBC
- E. International Fire Code
- F. International Mechanical Code
- G. International Electrical Code
- H. NFPA 101 – Life Safety Code
- I. NFPA 1 – Fire Prevention Code

1.4 SYSTEM DESCRIPTION

- A. Voice Evacuation Addressable Fire Alarm System: Non-coded, addressable microprocessor-based fire alarm system with initiating devices, notification appliances, monitoring and control devices, and connection to an approved Supervising Station. The Notification Appliances on this project shall be Speakers and Speaker Strobes. The use of Horn and Horn Strobes will not be permitted on this project. It is the responsibility of the system integrator to furnish the appropriate amount of signal extender and amplifier panels needed to support all notification appliances shown on the project drawings.

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1.5 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. A list of all equipment to be provided and installed in the system
 - b. Data sheets of all items to be provided with the specific item or model number highlighted
 - c. Required support documentation indicating the authorized relationship of the system supplier and copies of certifications and listings that are required in the specifications.
 - d. Fire Alarm Cable
 - e. Matrix of operation of the system
 - f. Standby battery calculations
 - 2. Upon approval of the submittal material, provide system drawings, prepared in AutoCAD, to include the following:
 - a. All control equipment with interconnecting wiring
 - b. Field connections of all circuits connecting to the control equipment
 - c. Floor layouts with fire alarm system device locations shown
 - d. Addressable device numbers for each addressable device
 - e. Notification appliances circuited and numbered, with candela setting for visual units and output setting for audible units
 - f. Typical device connections for each type device used in the system
 - g. Basic riser diagram to include control equipment and all field circuits
 - h. Indicate temperature settings of thermal detectors.
- C. Local Code Authority Submission: It shall be the responsibility of the Approved Equipment Supplier to provide the required materials and submittal data, including drawings, to the Local Authority Having Jurisdiction (AHJ) for their review and approval if necessary. Any fees for the submission and approval process shall be the responsibility of the installing contractor.

1.6 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record of Completion: The equipment supplier shall complete the Record of Completion as required in NFPA 72. Any deficiencies that are to be listed on the Record of Completion shall be reviewed with the Architect/Engineer on record for the project before the authority having jurisdiction is requested to sign the document. Upon approval, the original copy of the completed Record of Completion, signed by all required parties, shall be submitted through the Contractor to the Architect/Engineer and Building Owner.
- C. Drawings of the completed system reflecting any changes that were made from the original submission of drawings.
- D. Copy of the system program in printed form and on a USB thumb drive.
- E. Operating and Instruction Manuals of the entire system.
- F. Copy of the Testing and Maintenance Agreement for the first year of service.
- G. Copy of the Supervising Station Monitoring Agreement.
- H. Copy of the Certificate for Listing or Placarding the system.
- I. System Program: The equipment supplier shall provide a copy of the latest system program in printed form and on a USB thumb drive.

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1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Equipment Supplier: Shall be a local Company or local Branch office that is authorized by contract to provide all the products and equipment to be installed in the fire alarm and detection system. Upon request, a current letter provided within the past 30 days, shall be provided to the Architect/Engineer of the Authorized relationship between the Manufacturer and the Equipment Supplier. In addition, the Equipment Supplier shall have the following minimum certifications and listings:
 - 1. A minimum of one individual who works full time with the local office of the Equipment Supplier supporting this project who is NICET Certified in Fire Alarm Systems at Level IV or higher. A copy of a current Certification Certificate shall be included in the Submittal Data required above.
 - 2. The Equipment Supplier shall be listed by Underwriters Laboratories, Inc. (U.L.) under category UUJS for Protective Signaling Systems or Factory Mutual Research Approved (FM) for Fire Alarm Service – Local Companies under Standard 3011. A copy of a current Listing or Approved Certificate shall be included in the Submittal Data required above.
- C. Installer: Company specializing in installing the products specified in this section with minimum 3 years documented experience. Certified by the state and/or local governments as fire alarm installer when required by law. In lieu of the installers being certified when required by local AHJ, the Equipment Supplier shall be responsible for certifying the installation.

1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70, NFPA 72 and locally enforced codes.
- B. Furnish products listed and classified by UL, FM or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.
- C. Interconnecting equipment, initiation devices, notification appliance circuit extenders, and annunciating devices shall be UL listed to operate as a unit although manufacturers may differ.

1.9 MAINTENANCE SERVICE

- A. Inspection and Testing Agreement: As required for U.L. Certifying a Remote Supervising Station System, the Equipment Supplier shall furnish a full-service Testing and Maintenance Agreement to support the system during the first year of operation or for one year from Date of first beneficial use of the system. During this period, the Equipment Supplier shall provide the following at no additional cost to the Owner:
 - 1. Required Inspections and Testing
 - 2. Emergency Service during normal working hours
 - 3. Certifying the system for Remote Supervising Station service
 - 4. First Year monitoring service through a U.L. Listed Supervising Station or other Supervising Station approved by the local AHJ or Owner.
 - 5. Repair or replacement of any required parts, provided they have not been abused or misused by abnormal conditions such as vandalism, fire, water damage, lightning damage or other abnormal conditions.
- B. Service Not Covered by Above
 - 1. Service or labor desired by the Owner outside normal working hours of Monday through Friday from 8:00 AM to 5:00 PM shall be charged at the Equipment Suppliers normal published rates.
 - 2. Repair or replacement parts required due to abuse or other abnormal use, upon Owner approval shall be charged by the Equipment Supplier at published prices.
- C. Service Agreement Renewal: The Equipment Supplier shall provide to the Owner at the time the system is turned over for first beneficial use, a Service Agreement Renewal proposal to cover the following:
 - 1. Two (2) additional years for an Inspection, Testing and Maintenance Agreement to meet the current codes in effect.

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2. The proposal shall include the cost for re-certificating (U.L.) or placarding (FM) the system for Remote Supervising Station Service.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 1. Automatic Smoke Detector: Furnish 5 of each type and rating installed.
 2. Heat Detector: Furnish 5 of each type and rating installed.
 3. Manual Pull Station: Furnish 2 of each type and rating installed.
 4. Audible Indicating Devices: Furnish 2 of each type installed.
 5. Visual Indicating Devices: Furnish 2 of each type installed.
 6. Audible/Visual Devices: Furnish 5 of each type installed.
 7. Contact Interface Module: Furnish 1 of each type.
 8. Keys: Furnish 6 of each type.
 9. Handheld Detector Programmer: Furnish 1 of each type required.

1.11 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS AND OPERATIONS

2.1 MANUFACTURERS

- A. Provide a Fire Alarm and Automatic Detection System that is manufactured by a company that has a complete line of the products required for this project and has been successfully represented in this area for five years or more. Obtain fire alarm and automatic detection system components through one source from a single manufacturer who assumes responsibility for compatibility of system components. Following is a list of manufacturers that are known to meet these criteria. However, the specific equipment specifications and operations of the system to be provided for this project and the qualifications of the Authorized Representative (Equipment Supplier) of the manufacturer must meet or exceed the specifications to be considered for approval.
 1. Basis of Design: Silent Knight 6820EVS Series
 2. Siemens Fire Safety
 3. Edwards Systems Technology
 4. Notifier

2.2 FIRE ALARM CONTROL PANEL

- A. Control Panel: Modular construction with flush or surface wall mounted enclosure as indicated on the Drawings.
- B. Power supply: Shall be an integral part of the control equipment and include primary and secondary power circuits. The secondary supply shall automatically supply power to the system upon loss of primary power. The secondary power shall be sized to meet the Remote Station requirements of 24-hours of system operation under maximum quiescent load, plus 15 minutes of full load operation under an alarm condition. Provide power supplies and batteries with a minimum of 20% spare capacity. These secondary power capacities shall apply to all remote controls, alarm extender panels, supervising station reporting units and other ancillary controls provided with the system. Provide dedicated 24-volt DC power supplies for all magnetic door (smoke door) hold-open devices.
- C. System Supervision: All initiating device circuits, notification appliance circuits, and ancillary circuits shall be supervised as class B circuits. All end-of-line device locations shall be clearly marked on the drawings.
- D. Initiating Device Circuits: Signaling line circuits shall be limited to a maximum of 50 devices without short-circuit protection. Circuits over 50 devices shall require circuit isolation modules to prevent short-circuits

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from affecting more than 50 devices. Each initiating device circuit shall be loaded to not more than 80% of its maximum number of addresses.

- E. Emergency Communication System shall be complete, electrically supervised evacuation system using one-way communication with microprocessor-based operating system having the following capabilities, features and capacities:
1. Listed for emergency and non-emergency use.
 2. Listed for MNS from any control point to 'Request/Grant/Deny' and integrated with the system (no separate MNS panel).
 3. Ability to support up to two microphones per control panel for one-way paging, and up to 64 microphones in a voice network.
 4. Ability to provide manual voice control.
 5. Two channel message player supporting 300 messages (38 pre-recorded). The system supports MP3 and WAV files).
 6. Minimum of (1) simultaneous audio channel for each networked panel.
 7. Amplifiers shall be rated for 25V or 70.7V RMS, 50 watts. Voice amplification shall be supervised and backed up with like amplifiers. Back up shall be one or two per node.
 8. Ability to provide separate booster amplifier. Amplifiers shall be rated for 25V or 70.7V RMS, 100 watts.
 9. The system shall have the capability to support Peer-to-Peer or Master-Slave network and voice configurations.
 10. Multiple nodes shall provide peer-to-peer voice capability in order to eliminate a single point of failure.
 11. Audio shall be synchronized between nodes in order to take into account common areas.
 12. Speakers shall have the ability to play coded audio tones.
 13. The system shall provide status indicators and control switches for all the following functions:
 - a. Audible and visual notification alarm circuit zone control.
 - b. Speaker circuit zone control.
 - c. Status indicators for sprinkler system water flow and valve supervisory devices.
 - d. Any additional status or control functions as indicated on the drawings, including but not limited to emergency generator functions, fire pump functions, door unlocking, and security with bypass capabilities.
 14. The Voice Amplifier shall provide 25/70 V with a minimum of 50W amplifier. Up to four (4) amplifiers shall be capable of being are supported in a 3-to-1 backup, or 1-to-1 backup schematic on a single intelligent voice-communication system: configured as one (1), two (2) or three (3) main amplifiers, and one (1) or two (2) optional backup amplifiers.
 15. The Microphone Module shall be provided for live, non-pre-recorded voice communication on an intelligent voice communication panel. The microphone option module can serve either as a main microphone installed in the main-system enclosure, or as a remote microphone in a remote enclosure. Up to two (2) microphones are supported for each FACP.
 16. The Switch Option Module is a series of front-end, illuminated, and programmable pushbuttons primarily mounted in the middle inner door of each intelligent voice-communication FACP. Each switch- module has 24 group-switches, thus totaling 48 LEDs, and consists of up to 96 multi-color LED-status indicators. Each LED switch-group is assigned specific functionality during the configuration process. Furthermore, a pushbutton [for each affected zone] will illuminate to acknowledge the command has been received at the Voice System CPU Card. Additionally, if no microphone is used, up to eight (8) switch-option modules can be used in a given three-eight-unit (3HU) enclosure.
 17. The Booster Amplifier Option Module is a main board that allows for expansion of speaker zones for additional power to an intelligent voice communication system.
- F. Notification Appliance Circuits: Supervised notification modules, shall be installed as class B circuits with end-of-line device locations clearly marked on the drawings. Load signal circuits and modules to not more than 80% of rated capacity.
- G. Notification Appliance Circuit Supervision: All visual notification appliances throughout the facility shall be synchronized. All audible notification appliances throughout the facility shall be synchronized and operate on the temporal code 3 pattern. Visual and audible notification appliances shall be controlled independently allowing either to be silenced or operated manually at the control unit.

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- H. Digital Communicator: The Multi-Point Digital Alarm Communicator shall be UL864 listed to provide point identification of alarm, supervisory, security and trouble events to a Central or Remote Receiving Station. The DACT shall support the following:
1. Ademco Contact ID or SIA protocol
 2. Ademco Contact ID selection shall provide the ability to transmit events for up to 999 individual zones
 3. SIA selection shall provide the ability to transmit events for up to 10,000 individual points
 4. Programming of accounts and phone numbers
 5. Cellular connectivity.
 6. Line fault monitoring.
 7. Automatic 24-hour test
 8. The DACT supports configurable alarm, alarm restoral, trouble, trouble restoral, supervisory, supervisory restoral, and reset events.
 9. The DACT supports Ademco Contact ID alarm event codes for general alarm, smoke detector alarm, waterflow alarm, duct alarm, and manual alarm events.
 10. Optionally, the DACT can be programmed to report events by event queue only.
- I. Commercial Cellular LTE Communicator: Provide Starlink SLETEVI-CFB-PS, Advanced LTE Dual Diversity Antenna for optimized performance or equal as follows:
1. 3 LED Indicators - Green, Signal Strength; Amber- Busy/ Activation; Red-Trouble
 2. Patented Signal Boost™ signal amplification circuit and high-gain performance antennae
 3. Operating Environment: 0 to 49°C (32-120°F), up to 93% humidity (non-condensing)
 4. 12V - 24V Universal FACP Support, auto-current sensing. Support all brands communicating in Contact ID and 4/2
 5. Locking Metal Enclosure with Hinged door & 2 key-slots for wall mounting (LED indicators, inside) • Dimensions: 9-5/8"x 11-3/4" x 3-3/8"D (HxWxD) • Weight: 8 lbs (max., power supply models)
 6. Electrical Ratings for 120VAC, 60Hz • For Models with Power Supply: • Input Voltage: 120VAC Nominal • Input Current: 400mA maximum • Maximum Charging Current: 200mA
 7. The Communicators shall each be installed to meet the requirements of NFPA 72, 2013 for Secondary Power as required for Remote Station Supervising Station reporting. The system shall be programmed to report, as required in NFPA 72, 2013 for sole path reporting. The equipment supplier shall provide monitoring by a UL Listed supervising station and include the first-year monitoring fee as part of this contract. This contractor shall wire, connect, and test the operation of the communicators.
 8. Project shall include one years' annual monitoring of the Fire Alarm System. Monitoring shall be provided by a UL listed, approved Central Station. The Central Station shall be approved by the Professional Engineer and authority having jurisdiction and include required daily test reporting.
- J. Supervising Station Signal Transmitter: Provided as part of the system, shall be a Digital Alarm Communications Transmitter (DACT) that is capable of reporting the following signals to a U.L. Listed Supervising Station:
1. Alarm Conditions
 2. Trouble Conditions
 3. Supervisory Conditions
 4. Provide capability to provide additional signals as required by the AHJ.
 5. The DACT shall be installed to meet the requirements of NFPA 72 with 2 telephone line connections, and 24-hour standby power as required for Remote Station Supervising Station reporting. The system shall be programmed to report, as a minimum, every 24 hours to the Supervising Station and shall alternate telephone lines for reporting purposes. Unless otherwise directed by the Building Owner, the equipment supplier shall provide the connections to the supervising station and include the 1st year monitoring fee as part of this contract. The Building Owner shall be responsible making the 2 telephone lines available for connection to the DACT and provide a list of personnel to be contacted by the Supervising Station should the need arise. This contractor shall wire, connect, and test the operation of the DACT.
 6. If the system is certificated as a Central Station system, the battery standby may be reduced to 24 hours of standby power capacity.
 7. Project shall include one years annual monitoring of the Fire Alarm System. Monitoring shall be provided by a UL listed, approved Central Station. The Central Station shall be approved by the Professional Engineer and authority having jurisdiction and include required daily test reporting.
- K. Auxiliary Relays: Provide sufficient SPDT auxiliary relay contacts to provide accessory functions specified. The relay control wiring shall be electrically supervised by the Fire Alarm System to within three feet of the device or equipment to be controlled.

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- L. The front panels of all Remote Annunciators shall include Operator controls for ALARM, TROUBLE and SUPERVISORY ACKNOWLEDGE/SILENCE, NOTIFICATION APPLIANCE SILENCING, NOTIFICATION APPLIANCE RESOUND, and SYSTEM RESET. These operations shall be protected in order that only personnel with equipment keys have access to these functions.
- M. Trouble Sequence of Operation: Any "TROUBLE" condition in the system shall cause the following system operations:
 - 1. Indicate an alphanumeric message on the Main Control Unit and all Remote Annunciators of the specific trouble condition.
 - 2. Cause an audible trouble signal and "trouble" Lamp or LED to operate on the Main Control Unit and all Remote Annunciators. The audible trouble signal may be silenced, but the visual signal shall remain on until the trouble is corrected, and the system is reset.
 - 3. Cause a "trouble" signal to be transmitted to the Supervising Station.
- N. Alarm Sequence of Operation: Any "ALARM" condition in the system shall cause the following system operations:
 - 1. Indicate an alphanumeric message on the Main Control Unit and all Remote Annunciators of the specific device that caused the "Alarm" condition
 - 2. Cause an "Alarm" Lamp or LED to operate on the Main Control Unit and all Remote Annunciators. The "Alarm" lamp or LED shall remain on until the device and system is reset.
 - 3. Cause all notification appliances in the facility to operate unless the specifications and/or drawings indicate zone or floor control of notification appliances.
 - 4. Cause an "Alarm" signal to be transmitted to the Supervising Station. The signal shall remain operated until the system is reset at the Main Control Unit or Remote Annunciators.
 - 5. Operate the following control functions if applicable:
 - a. Elevator recall to main floor and alternate floor as required by the AHJ
 - b. Allow all doors held open by door holders to close depending on the zone in alarm.
 - c. If a duct detector is in alarm, cause its respective air handling unit fan to shut down. The duct detector in alarm shall be programmed as a "supervisory" function per NFPA 90A, unless otherwise required to report as an alarm condition by the local AHJ.
 - d. Any security or access-controlled doors or gates shall be released as required by the local AHJ or Building Owner Representatives.
 - e. Output contact to lighting control panel input to enable selected lighting.
- O. Supervisory Sequence of Operation: Any "SUPERVISORY" condition in the system shall cause the following system operations:
 - 1. Indicate an alphanumeric message on the Main Control Unit and all Remote Annunciators of the specific "Supervisory" condition.
 - 2. Cause an audible "Supervisory" signal and "Supervisory" Lamp or LED to operate on the Main Control Unit and all Remote Annunciators. The audible "Supervisory" signal may be silenced, but the visual signal shall remain on until the "Supervisory" condition is corrected. Upon correcting the "Supervisory" condition, the "Supervisory" signal shall resound and require acknowledgement. The system can then be reset.
 - 3. Cause a "Supervisory" signal to be transmitted to the Supervising Station upon activation and the back-to-normal condition.
 - 4. Supervisory conditions shall include, but not limited to, the following conditions as they apply to this project:
 - a. Sprinkler system valve tamper/shutoff and PIV switches
 - b. Sprinkler system fire pump signals (minimum of 3 signals)
 - c. Sprinkler system valve room – low temperature
 - d. Duct detectors, unless directed otherwise by the local AHJ.
 - e. Other conditions as listed in these specifications, shown on the drawings, or as directed by the local AHJ.
- P. Function Switches: Included on Main Control Panel shall be a minimum of 12 manual function switches or pushbuttons that can be programmed to include the items listed below and other functions required in these specifications, shown on the drawings or desired by the Building Owner:
 - 1. System DRILL function
 - 2. Bypass Supervising Station Alarm Functions ONLY – Trouble and Supervisory conditions shall continue to report to the Supervising Station
 - 3. Bypass Audible Notification Appliances

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4. Bypass Visual Notification Appliances
 5. Bypass Door Holders
 6. Bypass all Smoke Detectors
 7. through 12 – programmed per the requirements of the specifications, drawings, local AHJ requirements or Building Owner
 8. Operation of any of the above function switches shall cause a “trouble” condition on all Remote Annunciators and cause a report to the Supervising Station. The function switch operation shall be accessible through locked cabinet doors or other acceptable protection to limit access to authorized personnel only.
- Q. Control Equipment Display: All Remote Annunciators shall contain a minimum 80-character alphanumeric display for indicating all system alarm, supervisory, trouble and system functions. A minimum of 32 characters shall be capable of being custom programmed for displaying alarm, supervisory and trouble conditions.
- R. System Record Document Box: A System Record Documents Box shall be provided as follows:
1. The SRD shall be UL Listed and constructed of 18-ga cold rolled steel with a powder coat finish.
 2. The cover shall be permanently screed with 1" high lettering “SYSTEM RECORD DOCUMENTS” with white indelible ink.
 3. The access door shall be locked with a 3/4" barrel lock and there will be a 12" stainless steel piano hinge.
 4. The SRD will have a minimum of 8 gigabyte digital flash memory drive with a slide tab that allows user to select USB-C or Micro USB connector for uploading and downloading information.
 5. The enclosure will supply 4 mounting holes. Inside will accommodate standard 8-1/2" x 11" manuals and document records.
 6. A legend sheet will be attached to the door for system required documentation, key contacts, and system information.
 7. The enclosure shall also provide 2 key ring holders with a location to mount standard business cards for key contact personnel.
- S. Transient Voltage Surge Suppression and Breaker Locks/Labels: Provide on all 120 VAC equipment, control panels, power supplies, etc., the following Transient Voltage Surge Suppression (TVSS) protection, Breaker Locks and Circuit Labels:
1. Space Age Electronics, Inc., part number E120V-GT.
 2. The unit shall be ANSI/ UL listed to standard 1449, 4th edition and will be labeled clearly with indelible ink.
 3. Be attached via the 3/4" rigid coupling, or surface mounted via the 2 external mounting holes.
 4. The unit shall have thermal fuses to protect against fire in short circuit conditions and will have 18" long, 14-ga wires (3x) with a green ground wire.
 5. The enclosure will be a non-dielectric material UL94 QMFZ2/8 grade material providing UV protection.
 6. The unit shall provide visual indication (LED) that unit is protecting and functioning.
 7. The location of each branch circuit disconnecting means shall be permanently identified at the control unit.
 8. System circuit disconnecting means shall be permanently identified as to its purpose in accordance with the following: (1) “FIRE ALARM” for fire alarm systems (2) “EMERGENCY COMMUNICATIONS” for emergency communications systems (3) “FIRE ALARM/ECS” for combination fire alarm and emergency communications systems
 9. For fire alarm and/or signaling systems, the circuit disconnecting means shall have a red marking.
 10. The red marking shall not damage the overcurrent protective devices or obscure the manufacturer's markings.
 11. The circuit disconnecting means shall be accessible only to authorized personnel.
 12. Mechanical Protection. The branch circuit(s) and connections shall be protected against physical damage.
 13. Circuit Breaker Lock. Where a circuit breaker is the disconnecting means, a listed breaker locking device shall be installed.

2.3 MANUAL PULL STATIONS

- A. Description: Addressable single-action pull-lever type with integral addressable module, arranged to communicate manual station status (normal, alarm, or trouble) to the FACP. Fabricated of plastic and

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finished in red with molded raised-letter operating instructions of contrasting color. Station shall show a visual indication of alarm. UL 38 Listed.

- B. Station Reset: Key or wrench operated switch.
- C. Mounting: Semi-flush (where possible) or surface mounted. Provide manufacturer's standard backbox for surface locations that match the manual station.
- D. Weatherproof Pull Stations: Where indicated or required because the environmental conditions (including temperature and humidity) can become outside the listed ratings of a standard pull station, provide the following:
 - 1. Provide manual pull stations that are suitable for the environment in which they are installed.
 - 2. If a non-addressable device is required, locate an addressable interface module in an accessible location within the listed environmental conditions of the module and as close as possible to the device.
- E. Indoor Protective Shield: Factory fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm.
 - 1. Provide for all manual pull stations.

2.4 SPOT TYPE AUTOMATIC DETECTION

- A. Description: All devices shall be UL listed. Include features and meet requirements as follows:
 - 1. Detectors shall be documented as compatible with the control equipment to which they are connected. Detectors shall be listed for the application indicated (i.e. ceiling, wall, below access floor, etc.)
 - 2. The environmental conditions (including temperature and humidity) of each detector location shall be within the detectors listed ratings. If the detector will be exposed to environmental conditions outside of its listed ratings, provide a device that is suitable for the environment in which it is installed. If a non-addressable device is required, locate an addressable interface module in an accessible location within the listed environmental conditions of the module and as close as possible to the device.
 - 3. Detectors installed in air plenums shall be listed for the air velocities present.
 - 4. Spot type smoke and heat detectors shall fit into a base that is common for both types of detectors.
- B. Indoor Protective Shield: Factory fabricated wire guard to protect the automatic detector from physical damage. UL listed for use with the automatic detector.

2.5 SPOT TYPE SMOKE DETECTORS

- A. Description: Addressable photoelectric-thermal type with the capability to program the detector for specific hazard profiles. The detector shall be intelligent and be able to determine the difference between actual fire conditions and deceptive phenomena such as dust, steam, aerosols, and other non-fire conditions. The detector shall be immune to false alarms, capable of automatically adjusting sensitivity to match the environment, and provide alarm verification.
- B. Communications: The detector shall provide bi-directional communications with the FACP. The control panel shall be capable of analyzing the signal from the detector's analog value for calibration, sensitivity, and address identification. The detector's sensitivity or application setting for specific hazard profiles shall be individually controlled by the FACP. If the detectors sensitivity becomes beyond an acceptable level for a predetermined duration, a trouble signal shall be initiated.
- C. Coverage Area: 900 square feet.
- D. In addition to the detection capabilities, the spot type smoke detectors shall include the following:
 - 1. Capability of programming the smoke detector for reporting alarms from smoke conditions only, abnormal thermal conditions only, or a combination of both.
 - 2. Capability of programming the smoke detector for alarm verification.
 - 3. Testing the smoke detector in the field before installation on a fixed or portable test unit for proper operation.

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4. An LED or multiple LED's that indicate a "normal" condition with one color LED and an "alarm" condition with a red blinking or steady LED.
5. Capability of adding the following auxiliary functions:
 - a. Relay base assembly for controlling local functions. The relay shall be independently programmable from the smoke detector.
 - b. Remote LED operation for the smoke detector alarm condition.
 - c. Audible base assembly that is programmable to operate when the smoke detector is in alarm condition or from any other alarm condition in the system.

2.6 SPOT TYPE THERMAL DETECTORS

- A. General: Thermal detectors shall be provided that are appropriate for the area installed and are addressable and programmable. It shall be the responsibility of the Equipment Supplier to provide the lowest temperature setting and operating characteristics of all spot type thermal detectors to provide the earliest detection of abnormal heat without unwanted alarms. If the incorrect temperature setting is installed, during the first year of operation, the Contractor shall be responsible for replacing the unit with the correct temperature device. In all cases, each spot type thermal detector shall report as individual addressable points on the system.
- B. Addressable Combination Fixed Temperature/Rate-of-Rise Detectors: Addressable self-restoring combination Fixed Temperature and Rate-of-Rise. Fixed temperature element shall be rated for 135°F and 15° per minute rate-of-rise. Capability shall be provided to disable the rate-of-rise feature and allow the detector to perform just fixed temperature detection. Coverage area shall be 2500 square feet.
- C. Non-Addressable Devices:
 1. Install non-addressable devices only where the location exceeds the environmental ratings of the addressable devices. For each non-addressable device, provide an addressable interface module in an accessible location within the listed environmental conditions of the module and as close as possible to the device.
 2. Fixed Temperature/Rate of Rise Detectors: Fixed temperature element shall be rated for 135 or 200°F and 15° per minute rate-of-rise. Coverage area shall be 2500 square feet.
 3. Fixed Temperature Detectors: Fixed temperature element shall be rated for 135 or 200°F. Coverage area shall be 625 square feet.
 4. Rate Compensation/Fixed Temperature Detectors: Self restoring and rated either 135 or 200°F. Coverage area shall be 2500 square feet. Detectors shall be totally enclosed and weatherproof for installation in extremely dusty, wet, or humid locations.
 5. Other non-addressable thermal detectors may need to be provided for locations requiring higher temperature ratings.

2.7 DUCT MOUNTED SMOKE DETECTORS

- A. Description: Addressable, photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions.
- B. Duct smoke detectors shall include the following:
 1. Duct mounted smoke detectors shall be provided with the same capabilities and functions as the spot type smoke detectors.
 2. Duct detector housing shall consist of a base which is common to the spot type automatic detection devices.
 3. The duct detector shall be rated for the air velocities, temperatures, and humidity expected during normal operation of the air handling system.
 4. The housing shall contain test ports for measuring airflow and testing.
 5. Auxiliary relay(s) shall be provided for the shutdown of the associated air handling unit(s). Locate this relay within 3' of the units control panel or starter.
- C. Remote Indicator: Provide remote indicators as required. All duct smoke detectors installed in concealed spaces shall be provided with a remote indicator consisting of alarm LED installed below the unit in order to facilitate locating the unit for testing and maintenance purposes. Coordinate remote indicator locations with Owner/Engineer before roughing-in.

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- D. Weatherproof Enclosures: Where indicated or required provide enclosure complying with NEMA 250 requirements for Type 4X. Where subject to ambient temperatures below the rating of the duct smoke detector, provide insulation, strip heater, power supplies and thermostat.

2.8 MULTI-CRITERIA DETECTOR

- A. Description: Provide an addressable multi-criteria detector with CO sensor that shall support the use of an ambient Carbon Monoxide (CO) warning signal at the panel. This ambient CO level shall be user-configurable in parts per million (PPM) for the set threshold of the warning and event type generated by the warning. This event can be used to trigger system logic.
- B. The CO sensor may be programmed as part of the multi-criteria detector or may be an independent CO detector.
- C. Each CO detector shall be supplied with a local sounder base that is programmed to activate when CO is detected. This base shall be powered and supervised by the Fire Alarm System in accordance with NFPA 72 and shall be UL listed as a component of the Fire Alarm System and Detector. The sounder base shall be 520Hz if supplied in a sleeping room.

2.9 ADDRESSABLE INTERFACE MODULES

- A. Description: Addressable Interface Modules provide a means of interfacing for monitor or control of non-addressable devices to the fire alarm system. Fire alarm addressable module devices shown on the plans are not intended to indicate quantity, only that the fire alarm interface is required. Provide the quantities of module devices and interface wiring as required to meet NFPA 72 and other applicable code requirements.
- B. Addressable Monitor Modules: Provide means to monitor the status of a normally open or closed contact. Some functions that require addressable monitor modules include:
 - 1. Sprinkler System
 - 2. Kitchen Hood Systems Monitoring
 - 3. Ancillary Fire Protection Systems
 - 4. Knox Box
 - 5. Non-Addressable Devices
- C. Addressable Control Module: Provide means to control equipment using a form C relay consisting of one normally open and one normally closed contact. Contact rating shall be as required for control function. Some functions that require addressable control modules include:
 - 1. Smoke Door Holder Control
 - 2. Air-Handling Unit Control
 - 3. Smoke Control Functions
 - 4. Elevator Controls
 - 5. Security, Access-Controlled Doors and Gates
 - 6. Ancillary Fire Protection Systems
 - 7. Sound System Equipment
- D. Addressable interface modules shall include the following:
 - 1. The interface modules shall be individually addressable and custom programmed for the items they monitor or control
 - 2. The interface module shall mount on a 4" square outlet box and be provided with a faceplate.
 - 3. Each module shall be provided with a label identifying the address and the control or monitor function.
 - 4. Modules shall include a status LED identifying normal condition, unit malfunctioning, and change of state.

2.10 NOTIFICATION APPLIANCES

- A. Description: UL listed speaker and visual units for fire alarm notification.
- B. Combination Units: UL listed speaker and visual units as required for application.

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- C. Mounting: Wall mounted, or ceiling mounted. Semi-flush (where possible) or surface mounted. Provide manufacturer's standard back box for surface locations that match the notification appliance.
- D. Indoor Protective Shield: Factory fabricated wire guard or clear plastic enclosure to protect the notification appliance from physical damage. UL listed for use with the notification appliance.
- E. Weatherproof Notification Appliances: Where indicated or required because the environmental conditions (including temperature and humidity) can become outside the listed ratings of standard devices, provide weatherproof notification devices suitable for the environmental conditions in which it is installed.
- F. Color: White with red lettering unless directed otherwise by Architect.

2.11 AUDIBLE NOTIFICATION APPLIANCES (SPEAKERS)

- A. UL 1480 listed fire alarm speakers.
- B. Field Selectable Taps: 1/8, 1/4, 1/2, 1, and 2 Watts
- C. Field Selectable Taps for large spaces or spaces with high average ambient sound levels: 1/2, 1, 2, 4 and 8 Watts.
- D. Audible devices shall meet the requirements of voice intelligibility per NFPA 72.
- E. Audible device shall be 520HZ if installed in a sleeping room.

2.12 VISUAL NOTIFICATION APPLIANCES

- A. Xenon strobe lights with clear polycarbonate lens and the word "FIRE" is engraved in minimum 1" high letters. UL 1971 listed.
- B. Field Selectable Candela Settings:
 - 1. Wall: 15/30/75/110
 - 2. Ceiling: 15/30/75/95
- C. Field Selectable Candela Settings for large rooms and spaces:
 - 1. Wall: 135/185
 - 2. Ceiling: 115/177

2.13 KNOX BOX

- A. Provide a flush mounted Knox Box at locations where required by local AHJ, fire marshal, fire chief, etc. and meeting their key requirements. Surface mounted will be acceptable in existing walls. Connect to fire alarm system with a monitor module to provide a supervisory condition.

2.14 REMOTE ANNUNCIATOR

- A. LCD Annunciator:
 - 1. Provide a duplicate annunciator with all functions of the fire alarm control panel including Acknowledge, Silence, and Reset switches. Annunciator shall be capable of monitoring the entire system and full system control.
 - 2. Provide a supervised remote microphone with a push-to-talk microphone and operator interface panel. Remote microphone shall be included in the Remote Annunciator Enclosure.
 - 3. Provide at locations indicated on the drawings.

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2.15 FIRE ALARM COMMAND CENTER

- A. The fire alarm command center shall contain the following:
 - 1. Combination supervised remote microphone and annunciator.
 - 2. UL requirements for a LOC (Local Operator's Console)
 - 3. Capable of performing complete operation of the fire alarm system, including LED display, acknowledge, silencing, and resetting.
 - 4. 8 pre-programmed buttons for voice communications.
 - 5. Flush mount installation.
 - 6. Provide (1) in the office area at a location coordinated with the AHJ.

2.16 FIRE ALARM CABLE

- A. Manufacturers:
 - 1. Belden
 - 2. West Pen
 - 3. General
- B. Non-Power-Limited Circuits: Solid copper conductors with 600-V rated, 75°C, color-coded insulation. Wire type and sizes shall be as recommended by manufacturer.
- C. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP. Wire type and sizes shall be as recommended by manufacturer.
- D. All fire alarm cable shall be plenum rated.

2.17 SYSTEM RECORD DOCUMENTS BOX

- A. Space Age Electronics model SSU01690 (System Record Documents Cabinet - Black with your custom screened logo.)
- B. Box shall meet the requirements of NFPA 72 – 7.7.2.1, 7.7.2.4, 7.5.6.7, & 7.2.1.
- C. The SRD System Record Documents Box shall be UL Listed, constructed of 18-ga cold rolled steel and have a powder coat finish.
- D. Dimensions are 12" wide x 13" tall and 2-1/4" deep
- E. The cover shall be permanently screed with 1" high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
- F. The access door shall be locked with a 3/4" barrel lock and there will be a 12" stainless steel piano hinge.
- G. The SRD will have a minimum of 8 gigabyte digital flash memory drive with a slide tab that allows user to select USB-C or Micro USB connector for uploading and downloading information.
- H. The enclosure will supply 4 mounting holes. Inside will accommodate standard 8-1/2" x 11" manuals and document records.
- I. A legend sheet will be attached to the door for system required documentation, key contacts and system information.
- J. The enclosure shall also provide 2 key ring holders with a location to mount standard business cards for key contact personnel.
- K. Provide (1) for the project installed at a location coordinated with the Owner/Architect/Engineer

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2.18 FIRE ALARM BREAKER LOCKOUT

- A. Space Age Electronics Model ELOCK-FA (Circuit Lockout Kit).
- B. NFPA 2016 Code Compliance:
 - 1. 10.6.5.2 Circuit Identification and Accessibility
 - 2. 10.6.5.2.1 The location of the branch circuit disconnecting means shall be permanently identified at the control unit
 - 3. 10.6.5.2.2 System circuit disconnecting means shall be permanently identified as to its purpose in accordance with the following:
 - a. (1) "FIRE ALARM" for fire alarm systems
 - b. (2) "EMERGENCY COMMUNICATIONS" for emergency communications systems
 - c. (3) "FIRE ALARM/ECS" for combination fire alarm and emergency communications systems.
 - 4. 10.6.5.2.3 For fire alarm and/or signaling systems, the circuit disconnecting means shall have a red marking.
 - 5. 10.6.5.2.4 The red marking shall not damage the overcurrent protective devices or obscure the manufacturer's markings.
 - 6. 10.6.5.2.5 The circuit disconnecting means shall be accessible only to authorized personnel.
 - 7. 10.6.5.3 Mechanical Protection. The branch circuit(s) and connections shall be protected against physical damage.
 - 8. 10.6.5.4 Circuit Breaker Lock. Where a circuit breaker is the disconnecting means, a listed breaker locking device shall be installed.
- C. Provide (1) for every circuit breaker feeding power to fire alarm panels.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Manufacturer's Installation Requirements: Install products in accordance with manufacturer's instructions and the minimum requirements of the latest edition of the National Electric Code (NEC), NFPA 72 and IBC.
- B. Mounting Heights: All devices shall be mounted at heights indicated below or as otherwise noted on the drawings:
 - 1. Pull stations: 42 to 44" above finished floor to operating handle or lever.
 - 2. Audible and Visual Notification Appliances: 80" to 96" above finished floor.
 - 3. Audible and Visual Notification Appliances-Special Circumstances:
 - a. Multipurpose Room: 96" above finished floor.
 - b. Library: 96" above finished floor but not less than 6" below ceilings and soffits.
- C. Minimum Wire Size: Use 16 AWG minimum size conductors for fire alarm detection and signal circuit conductors.
- D. Color Coded Wires: Provide fire alarm circuit conductors with insulation color coded or use colored tape at each conductor termination and in each junction box. Numbered wires may be substituted for color coded wires. Show numbers or color code on system wiring diagram.
- E. End-of-Line Devices: Mount end-of-line device in box with last device or separate box adjacent to last device in circuit. Indicate the exact location of the end-of-line device on the as-built drawings.
- F. Connections to Auxiliary Devices: Provide conduit and wiring connections to door release devices, door hardware packages, fire suppression system control panels, motorized smoke dampers and security systems.
- G. Trim Rings: Provide trim rings where flush mounted initiating and signaling devices do not completely cover the opening in the wall or ceiling surface.
- H. Telephone Lines: Provide two telephone lines directly to telephone terminal board for direct connections to outside lines for connection of the DACT by the contractor responsible for telecommunications.

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- I. New Panel Power: Provide 1P.20A breaker in closest normal panel and connect to main fire alarm panel with 2 #12 + 1 #12 gnd in 3/4" conduit unless otherwise indicated.
- J. Additional panels added by manufacturer: Provide 1P.20A breaker in closest normal panel and connect to additional panel with 2 #10 + 1 #10 gnd in 3/4" conduit unless otherwise indicated.
- K. Provide fire alarm breaker lockout for all circuit breakers feeding fire alarm equipment.
- L. Provide system record document box at location coordinated with Owner/Architect/Engineer.
- M. Interconnection to Lighting Control System: There shall be an interconnection to the Lighting Control System. Provide fire alarm IM relay to initiate dry contact closure on Lighting Control System.
- N. Notification appliances shall meet all applicable codes. Notify the engineer of any problem areas before installation commences. The engineer will review all recommendations for the potential problem areas and advise in writing if additional items or changes are required. Any additional devices required after this point of the project are to be provided at no additional cost to the project.
- O. Measure ambient sound levels once the building is occupied and adjusts audible device tap setting to meet all applicable codes. Tap settings shall be field adjusted to the lowest tap that meets code. Tap settings shall be indicated on the installation and record drawings.
- P. Locate strobe devices at locations indicated on the drawings. A device is only to be relocated if the device is in conflict with casework, equipment, etc. Do not center strobes on walls unless indicated to do so. Set field selectable strobe settings to meet applicable codes. Settings shall be indicated on the installation and record drawings.
- Q. Install automatic detection so it does not exceed the listed spacing and meets the requirements of NFPA 72. Do not locate automatic detection closer than 3' from HVAC grilles.
- R. Install the elevator smoke detectors, heat detectors, and control circuits per NFPA 72 and all applicable codes.
- S. The EC shall furnish the duct smoke detector bases, sampling tubes, and weatherproof enclosures (where applicable) to the MC for installation in/on the ductwork. The EC shall provide the duct smoke detector on the base, fire alarm control relay for AHU shutdown, remote test station (where applicable), and all wiring to/from Fire Alarm Control Panel, duct smoke detector, remote test station, fire alarm control relay, and AHU Controller (for AHU shutdown).

3.2 WIRING METHODS

- A. Wire Routing: Route all device wiring from each device up into ceiling cavity within metallic conduit in recessed or unfinished areas or within surface raceway for renovated non-fishable areas. Stub all conduits into ceiling cavity and provide protective bushing for each.
- B. Cable Routing: Route cable for all device wiring within accessible ceiling cavities. Install in bridle rings at 4' spacing maximum. No cabling is to lie on or attach to ceiling tile, ducts, pipes, conduits or ceiling suspension wires, rods, or structural members. Provide conduit stubs from devices and panels to the ceiling cavities.
- C. Route all fire alarm wiring from fire alarm panel within metallic conduit up into nearby ceiling cavity and connect to the wiring system indicated in A and B above. Provide bushings at conduit ends.
- D. Provide raceways for cabling in all open structure spaces.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 260010.

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- B. Acceptance Testing: A 100% Acceptance Test shall be conducted by the Approved Equipment Supplier to meet the requirements of NFPA 72 Chapter 7. The Record of Completion shall indicate the total number of items tested in the system.

3.4 AUTHORIZED EQUIPMENT SUPPLIER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Section 260010.
- B. Include services of certified technician to supervise installation, adjustments, final connections, and system testing as required by local codes.
- C. Program the actual owner-assigned room names/numbers for alarm location indication on displays. System is not considered acceptable with architectural or manufacturer assigned numbers for spaces and devices. In addition, the Equipment Supplier shall reprogram the labels in the system at no charge during the first year of operation as desired by the Building Owner.

3.5 TRAINING

- A. Personnel Training: Provide and pay for the services of a factory-authorized service representative to demonstrate the system and train Owners personnel.
 - 1. Provide training for operating, testing, troubleshooting and general maintenance of the system.
 - 2. Provide a minimum of two, 2-hour sessions with at least 2 weeks advance notice and 2 weeks apart.
 - 3. Provide documentation of sessions to Architect/Engineer with signatures of at least 3 Owners Representatives present at demonstration.

3.6 SEQUENCE OF OPERATIONS

- A. Upon a duct mounted smoke detector alarm condition, the auxiliary relay provided with the smoke detector shall be wired by the electrical contractor to the mechanical equipment's starter and shut down its respective unit. An alarm or trouble signal shall be sent to the fire alarm control panel.
- B. Refer to Section 260180 for interface with elevator.

3.7 TOWNSHIP/FIRE MARSHAL DRAWINGS

- A. The Contractor shall provide CAD Drawings on 11" x 17" sheets showing all device locations with identification numbers attached. These drawings shall show all devices within the building. These drawings shall be turned over to the township representative/fire marshal for their approval.

END OF SECTION 283111