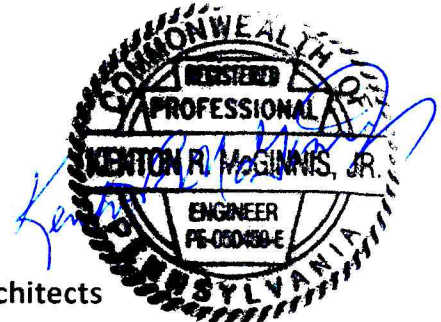
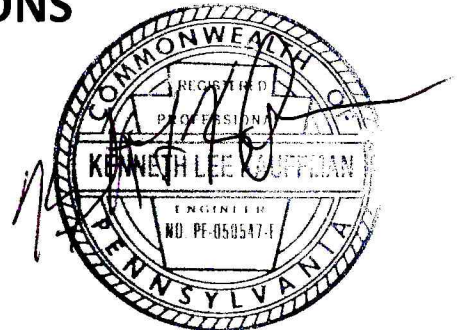
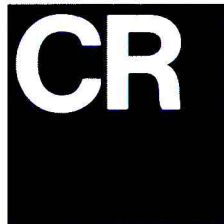
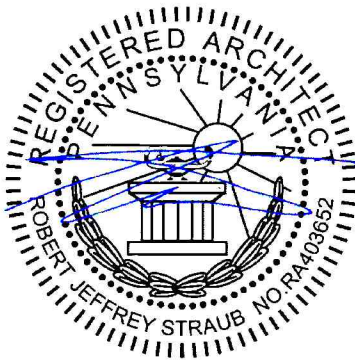


The School District of Haverford Township Additions and Renovations to Coopertown Elementary School

VOLUME 3 DIVISIONS 21 through 23 DIVISIONS 26 through 28 TECHNICAL SPECIFICATIONS

CRA PROJECT NO. 3758

March 10, 2025



Crabtree, Rohrbaugh & Associates - Architects

401 East Winding Hill Road, Mechanicsburg, PA 17055

www.cra-architects.com

P: 717.458.0272

Maryland • Pennsylvania • Virginia • West Virginia

VOLUME 3

TECHNICAL SPECIFICATIONS

FOR

**ADDITIONS AND RENOVATIONS TO
COOPERTOWN ELEMENTARY SCHOOL**

FOR THE

**THE SCHOOL DISTRICT OF HAVERFORD TOWNSHIP
50 East Eagle Road
Havertown, PA 19083**



**CRABTREE, ROHRBAUGH & ASSOCIATES
ARCHITECTS**

401 East Winding Hill Road
Mechanicsburg, Pennsylvania 17055

ARCHITECT'S PROJECT NO. 3758

SECTION 210010 – FIRE SUPPRESSION 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. Fire Suppression System
- C. The Fire Protection Contractor (FPC) shall be a sub-contractor to the Plumbing Contractor.

1.3 UNIT PRICE ITEMS

- A. Refer to Section 012129 and 012200

1.4 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, conduits and accessories for control devices shall be furnished and installed by the Contractor who provides the plumbing equipment.
- 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 Fire Suppression Contractor shall be responsible for any additional costs incurred or coordination required.
- I. Refer to the electrical specification section 260180, Coordination of Responsibilities.

1.5 RULES AND REGULATIONS

- A. All work shall be performed in accordance with the current adopted rules and regulations of authorities having jurisdiction of the National Plumbing Code, local plumbing codes, the utilities having jurisdiction, International Plumbing Code, International Building Code, International Mechanical Code, NFPA Code, Uniform Plumbing Code, International Fire Code, International 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 Health, 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 to 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. Refer to Specification Section 00750 for details.

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. Refurbishment - Disassemble existing equipment and reassemble to its original factory condition by means of cleaning the equipment and replacing missing, damaged or worn components.
- G. Furnish - The term furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.
- H. 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.
- I. Provide - The term provide means to furnish and install, complete and ready for the intended use.
- J. Contractor - The Contractor, Sprinkler Contractor, Fire Protection Contractor, FPC or SC - The terms mean the Contractor responsible for all work under this Division.
- K. 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 are 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.

- L. 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.
- M. 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.
- N. AHJ – Authority Having Jurisdiction
- O. 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. ASHRAE American Society of Heating, Refrigeration and Air-Conditioning Engineers
 - 2. ACI American Concrete Institute
 - 3. ADA Americans with Disabilities Act
 - 4. AISC American Institute of Steel Construction
 - 5. AISI American Iron and Steel Institute
 - 6. ANSI American National Standards Institute
 - 7. ASTM American Society for Testing and Materials
 - 8. AWS American Welding Society
 - 9. CRSI Concrete Reinforcing Steel Institute
 - 10. ETL ETL Testing Laboratories Inc.
 - 11. ISA Instrument Society of America
 - 12. NEC National Electrical Code
 - 13. NFPA National Fire Protection Assoc.
 - 14. UL Underwriters Laboratories, Inc.
- P. 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
 - 4. OSHA Occupational Safety and Health Administration (US Department of Labor)
 - 5. REA Rural Electrification Administration (US Department of Agriculture)

1.7 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 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, 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.

1.8 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 Front End 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 specification. Contractors will be responsible to insure 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.

1.9 VISIT TO THE SITE

- A. Prior to submission of his bid, the Contractor shall visit the site to acquaint himself with the existing conditions. Bids as submitted will be interpreted to include all costs and change made necessary by such conditions.

1.10 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.

1.11 LOCATION OF EQUIPMENT

- A. All locations of fire protection 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.

1.12 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.

1.13 WORKMANSHIP

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

1.14 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.

1.15 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.
- 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.

1.16 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.

1.17 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.

1.18 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 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 patching not deemed suitable by the Architect will be replaced by the Owner at the expense of the related contractor.

1.19 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.

1.20 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.

1.21 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.

1.22 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.

1.23 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.

1.24 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.

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 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.
- 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.
- E. The space between pipes/ducts and sleeves shall be caulked air tight 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 require 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 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.

2.7 ACCESS PANELS

- A. Removable panels shall be located so as 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.

2.8 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.

2.9 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.
- B. Water pipe installed under floor shall be installed in a schedule 40 PVC pipe conduit sleeve.

2.10 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.

2.11 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 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.

2.12 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 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.

2.13 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.

END OF SECTION 210010

SECTION 210100 – FIRE SUPPRESSION GENERAL EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Flexible Pipe Connectors
- B. Pressure Gages and Pressure Gage Taps
- C. Thermometers and Thermometer Wells
- D. Pipe and Equipment Hangers and Supports
- E. Equipment Bases and Supports
- F. Sleeves and Seals
- G. Nameplates
- H. Tags
- I. Stencils
- J. Pipe Markers

1.2 REFERENCES

- A. ASME - B40.1 - Gages - Pressure Indicating Dial Type - Elastic Element.
- B. UL 393 - Indicating Pressure Gages for Fire and Protection Services.
- C. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- D. MSS SP58 - Pipe Hangers and Supports - Materials, Design, and Manufacturer.
- E. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- F. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- G. NFPA 13 - Installation of Sprinkler Systems.
- H. NFPA 70 - National Electrical Code.
- I. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 210010.
- 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. Gages and Meters: Provide list which indicates use, operating range, total range, and location for manufactured components.
 - 3. Supports and Anchors: Provide manufacturers catalog data including load capacity.
 - 4. Fire Suppression Identification: Provide manufacturers catalog literature for each product required.
 - 5. 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.

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

2.2 PRESSURE GAGES

- A. Manufacturer: Moeller
- B. Other acceptable manufacturers offering equivalent products:
 - 1. American
 - 2. Trerice
 - 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

2.3 PIPE HANGERS AND SUPPORTS

- A. Fire Protection Piping:
 - 1. Conform to NFPA 13, NFPA 14
 - 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.

2.4 PIPE HANGER ACCESSORIES

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

2.5 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.

2.6 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage 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.

2.7 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.

2.8 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.

2.9 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.

2.10 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 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 used in conjunction with CLK or FSP which provide a smoke seal.
 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. Gages and Meters:
 1. Install pressure gages with pulsation dampers. Provide needle valve to isolate each gage. Extend nipples to allow clearance from insulation.
 2. Provide instruments with scale ranges selected according to service with largest appropriate scale.
 3. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45° off vertical.
 4. Adjust gages to final angle, clean windows, and lenses, and calibrate to zero.
- B. Fire Suppression 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. Identify control panels and major control components outside panels with plastic nameplates.
7. Identify valves in main and branch piping with tags.
8. Tag automatic controls, instruments, and relays. Key to control schematic.
9. 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.

C. 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.

D. 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.
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 gauge galvanized steel and shall be 8" long.

- E. 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 air tight. 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 210100 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

END OF SECTION 210100

SECTION 210300 - FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe & Fittings
- B. Valves
- C. Wet-Pipe Sprinkler System
- D. System Design, Installation, Certification

1.2 SCOPE

- A. Provide and install a complete and operating sprinkler system in accordance with these specifications and accompanying contract drawings. This shall include all required labor, materials, equipment, supervision, and testing.
- B. The work includes the following systems, equipment, materials, and labor but is not necessarily limited by this summary.
 - 1. A complete wet type sprinkler system including all sprinkler heads, piping, and special valves. Protect all areas shown fully as required. System shall be designed for Light Hazard, and shall be hydraulically designed to provide 0.10 gpm per square foot over the most hydraulically remote 1,500 square foot area. System for areas such as Storage Rooms, Mechanical Rooms, Boiler Rooms, Platforms, etc. shall be designed for Ordinary Hazard, Group 1.
 - 2. All alarm and detecting devices. Provide tamper switches for all valves per NFPA #13.
 - 3. Inspectors test connections as required.
 - 4. Connection to the water main.
 - 5. Drains as required.
 - 6. Fire Department Connection
 - 7. Alarm Bell
 - 8. Fire Pump System

1.3 ELECTRICAL WIRING

- A. Electrical wiring shall be furnished and installed as part of this contract as described below.
- B. A full complement of electrical required for intended use and/or operation of specified equipment whether integral or remote, shall be furnished under this portion of specifications. Power wiring (Where required) through these devices shall be installed under Electrical portion of specifications. Control wiring, conduit, and accessories for these devices (flow switches, tamper switches, etc.) shall be furnished and installed under this portion of specifications. Connect to local Normal/Emergency Electric Panel on Emergency circuit. Responsibility for proper functioning of

equipment shall be under this portion of specifications. Where components are installed in locations exposed to weather, they shall be weatherproofed.

- C. Wiring from Fire Alarm System to tamper switches and flow switches will be by the EC.

1.4 REFERENCES

- A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- C. ANSI/ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings.
- D. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-welding and Threaded.
- E. ANSI/ASME B16.25 - Buttwelding Ends.
- F. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.
- G. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.
- H. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.
- I. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.
- J. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.
- K. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- L. NFPA 13 - Installation of Sprinkler Systems.

1.5 SUBMITTALS

- A. Submit in accordance with provisions of Section 210010.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- C. Shop Drawings: Indicate hydraulic calculations, detailed pipe layout, hangers and supports, components and accessories. Indicate system controls.
- D. Product Data: Provide data on sprinkler heads, valves, and specialties, including manufacturers catalogue information. Submit performance ratings rough-in details, weights, support requirements, and piping connections.

- E. Submit shop drawings, product data and hydraulic calculations to authority having jurisdiction, Fire Marshall and Owner's insurance underwriter for approval. Submit proof of approval to Architect/Engineer. Obtain approval prior to start of any work.

1.6 QUALITY ASSURANCE

- A. Sprinkler Systems: Perform work to NFPA 13, Fire Marshall, Local Authority, UL.
- B. Welding Materials and Procedures: Perform to ASME Code.
- C. Valves: Bear UL or FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

1.7 EXTRA MATERIALS

- A. Provide extra sprinkler heads under provisions of NFPA 13.
- B. Provide suitable wrenches for each head type.
- C. Provide metal storage cabinet in location designated.

PART 2 - PRODUCTS

2.1 SPRINKLER PIPING, BURIED

- A. Cast Iron Pipe: ANSI/AWWA C151, Cement lined ductile iron - Class 52.
 - 1. Fittings: ANSI/AWWA C110, standard thickness.
 - 2. Joints: ANSI/AWWA C111, tyton or mechanical joints.

2.2 SPRINKLER AND STANDPIPE PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53; ANSI/ASME B36.10; Schedule 10 or 40 black (Sprinkler), Schedule 40 black (Stand pipe).
 - 1. Steel Fittings: ANSI/ASME B16.9, wrought steel, buttwelded; ANSI/ASME B16.25, buttweld ends; ASTM A234, wrought carbon steel and alloy steel; ANSI/ASME B16.5, steel flanges and fittings; ANSI/ASME B16.11, forged steel socket welded and threaded.
 - 2. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.3 GATE VALVES

- A. Manufacturers:
 - 1. Grinnell
 - 2. Nibco

3. Mueller

- B. Up to and including 2": Bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge or disc, threaded ends.
- C. Over 2": Iron body, bronze trim, rising stem, handwheel, OS&Y, solid wedge, flanged or grooved ends.

2.4 GLOBE VALVES

- A. Manufacturers:
 - 1. Grinnell
 - 2. Nibco
 - 3. Mueller
- B. Up to 2": Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable composition disc, screwed ends, with backseating capacity.
- C. Over 2": Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat, and disc.

2.5 BALL VALVES

- A. Manufacturers:
 - 1. Nibco
 - 2. Approved equal
- B. Up to and including 2": Bronze one-piece body, brass ball, Teflon seats and stuffing box ring, lever handle threaded ends with union.

2.6 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Nibco
 - 2. Jamesbury
 - 3. Grinnell
- B. Cast or ductile iron body, chrome plated ductile iron disc, resilient replaceable EPDM seat, lug type, extended neck, handwheel and gear drive and integral indicating device and built-in tamper proof switch rated at 115 volt AC.

2.7 CHECK VALVES

- A. Manufacturers:
 - 1. Nibco
 - 2. Mueller
 - 3. Grinnell

- B. Up to and including 3": Bronze swing disc, screwed ends.
- C. Over 3": Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends, or wafer style.

2.8 DRAIN VALVES

- A. Manufacturers:
 - 1. Nibco
 - 2. Crane
 - 3. Stockham
- B. Bronze compression stop with hose thread nipple and cap.
- C. Brass ball valve with cap and chain, 3/4" hose thread.

2.9 SPRINKLER HEADS

- A. Manufacturers:
 - 1. Viking
 - 2. Grinnell
 - 3. Central
- B. Suspended Ceiling:
 - 1. Type: Concealed sprinkler heads with cover plates.
 - 2. Head Finish: White
 - 3. Cover Plate Finish: White
 - 4. Glass bulb temperature rated for specific area hazard.
 - 5. Wet or dry type as indicated in plans.
 - 6. Quick Response Type
- C. Exposed Area Type:
 - 1. Type: Standard upright type with guard.
 - 2. Head Finish: White.
 - 3. Fusible Link: Glass Bulb temperature rated for specific area hazard.
 - 4. Wet
 - 5. Quick Response Type
 - 6. Guards: Finish to match sprinkler head.
- D. Use concealed sprinkler heads with cover plates for all ceiling clouds, wood ceilings, specialty ceilings (not drywall or acoustical ceilings), epic decks, and other areas as noted on the plans. Covers shall be custom color selected by the Architect.
- E. For freezer areas and canopy areas, use dry heads tied into the wet pipe system, field coordinate length of dry stem.
- F. Soffits: Sidewall Heads, quick response, color by Architect, matching escutcheon plate.
- G. Extended coverage sprinkler heads may be used if approved by all authorities having jurisdiction.

2.10 PIPING SPECIALTIES

- A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate hydraulically operated alarms, with pressure retard chamber and variable pressure trim, electrical-pressure flow switch, drain, gauges, testing apparatus and accessories.
- B. Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy red enameled gong and motor housing, nylon bearings, and inlet strainer. Electric alarm bell shall also be acceptable.
- C. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts, 115 volt AC.
- D. Fire Department Connection:
 - 1.
 - 2. Outlets: 2-way Siamese or stortz (verify with local authority) with thread size to suit fire department hardware; threaded dust cap and chain of matching material and finish.
 - 3. Drain: 3/4" automatic drip
 - 4. Label: "Sprinkler – Fire Department Connection"
 - 5. Provide Knox caps for Siamese outlets or Stortz outlet as applicable per NFPA 13.1.12
- E. Double Check Valve Assembly:
 - 1. Watts #709 Series
 - 2. Size - 8", 7.0 psig loss at 1000 gpm
 - 3. Epoxy coated cast iron check valve bodies with bronze seats furnished with bronze body ball valve, test cocks, stainless steel internal parts. Provide strainer and (2) O.S. & Y. Valves.

2.11 FIRE PUMP

- A. Furnish and install where shown on plans one (1) Peerless fire pump system complete with pump, driver, controller and accessories. The pumping unit shall be listed by Underwriters' Laboratories, Inc. and/or shall be fully approved by the Associated Factory Mutual Fire Insurance Companies, where applicable. The pumping unit shall meet all requirements of the National Fire Protection Association Pamphlet No. 20. The fire pump shall have a nameplate design capacity of 750 G.P.M. at 40 PSIG boost to existing suction pressure. The pump shall also deliver not less than 150% of rated capacity at a pressure not less than 65% of rated pressure. The shut off, or churn pressure shall not exceed 140% of rated pressure. Minimum suction pressure at the fire pump suction flange is [50 psi]. The pump shall operate at a maximum speed of 1780 rpm and have a minimum case working pressure of 175 PSIG.
- B. The fire pump shall be a PEERLESS MODEL 6PVF12 vertical inline centrifugal fire pump, size 6 x 6, bronze fitted, single stage, centrifugal pump.
- C. The driver shall be a vertical open drip-proof, ball bearing type, AC induction squirrel cage motor: 30 HP maximum, 1780 rpm, vertical solid shaft, wound for 208 volts, 3 phase, 60 Hertz. The motor shall be of such capacity that 115% of the full-load ampere rating shall not be exceeded at any condition of pump load, including in excess of 150% of nameplate capacity. The motor shall be

U.L. Listed for fire protection. Locked rotor current shall not exceed the values specified in the latest publication of N.F.P.A. Pamphlet No. 20.

- D. The fire pump unit shall include the following accessories, as required by N.F.P.A. 20 standards (depending on the conditions under which the pumps are to be installed):
1. Circulation relief valve
 2. Pressure gauge set
 3. Hose valve manifold, 6-inch grooved
 4. Set of three (3) 2-1/2-inch hose valves, with caps and chains
 5. Ball drip valve, 1/2-inch
 6. 6" Low suction control valve
- E. Control Equipment
1. The fire pump motor control shall be U.L. Listed and/or F.M. Approved, where applicable. It shall be completely assembled, wired and tested by the control manufacturer before shipment from the factory, and shall be labeled "Fire Pump Controller". The controller shall be located as close as practical and within sight of the motor. The controller shall be so located or protected that it will not be injured by water escaping from the pump or connections. The controller shall be of the combined manual and automatic Solid State Soft Start type with a circuit breaker interrupting capacity of 100,000 amperes at 208 volts and shall meet all of the latest requirements of N.F.P.A. pamphlet No. 20. Control equipment shall be manufactured by Tornatech. Model GPS + GPU.
 2. Furnish with main control panel an automatic transfer switch to automatically transfer to alternate source of power upon interruption of primary power source. Automatic transfer switch is to comply with specifications per N.F.P.A. Pamphlet No. 20, with alternate power source from emergency generator. Automatic transfer switch shall be manufactured by Russelectric Co., Asco, or Zenith, and be assembled and tested by the controller manufacturer to become a coordinated, integral part of the fire pump controller.
 3. The pump, driver, controller and all accessories shall be purchased under a unit contract. The pump shall be given a complete performance test with positive suction pressure. A certified performance curve shall be prepared and submitted. Pumps shall also be hydrostatically tested to twice the shut off pressure, but in no case less than 250 pounds per square inch.
 4. The pump manufacturer shall assume unit responsibility and shall provide the services of a factory-trained representative to be available to assist in conducting final field acceptance tests. The control panel representative (in addition to the fire pump representative) shall attend the acceptance test.
- F. Jockey Pump with Control Panel
1. The contractor shall furnish and install a Grundfos CR1-6 vertical multi-stage jockey pump to operate at 3450 rpm with a capacity of 8 gpm at a 62.8 psig boost to existing suction pressure. The pump shall be constructed with 304 stainless steel impellers and diffusers, a high temperature mechanical seal with carbon versus silicon carbide, EPDM elastomers throughout, tungsten carbide vs. ceramic pump bushings, and a cast iron motor bracket. Flanges will be ductile iron in slip ring (isolated from liquid) design.

2. Unit shall be coupled with a 3450 rpm NEMA motor of 1 HP, 3 phase, 208-volt TEFC enclosure using a rigid split coupling. Motor bearings shall be sized to allow a 20,000 minimum hour B10 calculated life.
3. The jockey pump control panel shall be Tornatech JPLT-460-1– 60 microprocessor jockey pump controller, complete with 3-position H-O-A selector switch with padlock cover, door-interlocked rotate type disconnect switch, fuseless motor starter with thermo-magnetic motor protector, horsepower rated contactor, and 316 stainless steel pressure transducer with 0-300 psi range.
4. Panel shall be wired for 208 volt, 3 phase, 60 Hz power. Controller manufacturer to be identical to the main fire pump controller manufacturer.
5. Furnish a 3/4-inch relief valve, set at 175 psi, for thermal and overpressure protection. Valve shall be installed on the pump side of the jockey pump discharge piping.

G. Contact Steven Brown at Steven Brown & Associates, Inc. (302-652-4723)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install piping in accordance with NFPA 13 for sprinkler systems and NFPA 14 for standpipe and hose systems.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, and not interfere with use of space and other work.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- G. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- H. Do not penetrate building structural members unless indicated.

- I. Provide sleeves when penetrating footings, floors, and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- J. Die cut screw joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- K. Install valves with stems upright or horizontal, not inverted. Remove protective coatings.
- L. Provide gate, ball, or butterfly valves for shut-off or isolating service.
- M. Provide drain valves at main shut-off valves, low points of piping and apparatus.
- N. For underground piping, provide thrust blocks at changes of direction.
- O. Install equipment in accordance with manufacturer's instructions.
- P. Install buried shut-off valves in valve box. Provide post indicator.
- Q. Provide double check valve assembly at sprinkler system water source connection.
- R. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent Siamese connectors to allow full swing of fire department wrench handle.
- S. Locate outside alarm gong on building wall as indicated.
- T. Place pipe runs to minimize obstruction to other work.
- U. Place piping in concealed spaces above finished ceilings.
- V. Center heads in ceiling tile.
- W. Flush entire piping system of foreign matter.
- X. Hydrostatically test entire system.
- Y. Require test be witnessed by Fire Marshall and/or authority having jurisdiction.
- Z. A 1" inspector test connection with a 2" smooth bore corrosion resistant outlet shall be installed on the end of the most distant sprinkler line in accordance with NFPA #13.
- AA. All valves on connections to water supplies and in supply pipes shall be approved indicating type. Valves shall be supervised open in an approved manner.
- BB. Check valves shall be approved straightway type that can be installed in a vertical or horizontal position.
- CC. Approved automatic ball drip shall be provided in the piping between the check valve and the outside hose coupling.

- DD. All valves shall be protected by tamper switches.
- EE. Furnish and install sleeves for all piping passing through floors, walls, partitions, slabs, grade beams, and foundations. Core drilled openings above grade in solid concrete need not be sleeved but must be clean and neat without cracking or spalling.
- FF. Stainless steel flexible sprinkler connections shall not be allowed.

3.3 FLOWTEST

- A. Contractor shall be responsible for conducting water system flow tests to determine system parameters needed for hydraulic design.
- B. For information only purposes and not to be used for design purposes, flowtests were performed at the school on September 18, 2023:
 - 1. Static Pressure –49 psig
 - 2. Residual Pressure – 42 psig @ 839gpm
 - 3. Static reading was taken from the hydrant located at Coopertown road & Stockton RD. and residual reading was taken from the hydrant located at Buck La. & Coopertown RD.

END OF SECTION 210300

SECTION 220010 - 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. Storm Water Piping System
 - 4. Natural Gas Piping System
 - 5. Domestic Water Heating System
 - 6. Condensate Piping System

1.3 UNIT PRICE ITEMS

- A. Refer to Section 012129 and 012200

1.4 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, conduits and accessories for control devices shall be furnished and installed by the Contractor who provides the plumbing equipment.
- 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.
- I. Refer to the electrical specification section 260180, Coordination of Responsibilities.

1.5 RULES AND REGULATIONS

- A. All work shall be performed in accordance with the current adopted rules and regulations of authorities having jurisdiction of the National Plumbing Code, local plumbing codes, the utilities having jurisdiction, International Plumbing Code, International Building Code, International Mechanical Code, NFPA Code, Uniform Plumbing Code, International Fire Code, International 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 Health, 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 to 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.

1.6 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. Refurbishment - Disassemble existing equipment and reassemble to its original factory condition by means of cleaning the equipment and replacing missing, damaged or worn components.
- G. Furnish - The term furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.
- H. 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.
- I. Provide - The term provide means to furnish and install, complete and ready for the intended use.
- J. Contractor - The Contractor, Plumbing Contractor, or PC - The terms mean the Contractor responsible for all work under this Division.
- K. 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 are 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.
- L. 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.

- M. 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.
- N. AHJ – Authority Having Jurisdiction
- O. 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. ASHRAE American Society of Heating, Refrigeration and Air-Conditioning Engineers
 - 2. ACI American Concrete Institute
 - 3. ADA Americans with Disabilities Act
 - 4. AISC American Institute of Steel Construction
 - 5. AISI American Iron and Steel Institute
 - 6. ANSI American National Standards Institute
 - 7. ASTM American Society for Testing and Materials
 - 8. AWS American Welding Society
 - 9. CRSI Concrete Reinforcing Steel Institute
 - 10. ETL ETL Testing Laboratories Inc.
 - 11. ISA Instrument Society of America
 - 12. NEC National Electrical Code
 - 13. NFPA National Fire Protection Assoc.
 - 14. UL Underwriters Laboratories, Inc.
- P. 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
 - 4. OSHA Occupational Safety and Health Administration (US Department of Labor)
 - 5. REA Rural Electrification Administration (US Department of Agriculture)

1.7 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 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, 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.

1.8 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 Front End 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 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.

1.9 VISIT TO THE SITE

- A. Prior to submission of his bid, the Contractor shall visit the site to acquaint himself with the existing conditions. Bids as submitted will be interpreted to include all costs and change made necessary by such conditions.

1.10 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.

1.11 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.

1.12 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.

1.13 WORKMANSHIP

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

1.14 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.

1.15 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.

- 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.

1.16 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.

1.17 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.
- I. All grading and seeding made necessary by work done under this contract shall be performed by the General Contractors excavator/landscape sub-contractor. PC shall pay this Contractor to perform all work.

1.18 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.

1.19 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 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 patching not deemed suitable by the Architect will be replaced by the Owner at the expense of the related contractor.

1.20 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. All costs associated with phasing and maintenance of services and systems to occupied areas shall be included in the bid even if not specifically indicated on the plans.

1.21 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.

1.22 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.

1.23 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.

1.24 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.

1.25 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 one year from date of final 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.

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.
- 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 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.
- E. The space between pipes/ducts 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 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.

3.7 SHOCK ABSORBERS

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

3.8 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.

3.9 ACCESS PANELS

- A. Removable panels shall be located so as 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.

3.10 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.

3.11 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.

3.12 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.

3.13 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.

3.14 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.

3.15 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 220010

SECTION 220100 - 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. NFPA 13 - Installation of Sprinkler Systems.
- J. NFPA 14 - Installation of Standpipe and Hose Systems
- 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. Submit in accordance with provisions of Section 220010.
- 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
 - 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" trave.

2.3 PRESSURE GAUGES

- A. Manufacturer: Moeller
- B. Other acceptable manufacturers offering equivalent products:
 - 1. American
 - 2. Trerice
 - 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: Weksler AADHFC
- B. Other acceptable manufacturers offering equivalent products:
1. American
 2. Trerice
 3. Moeller
 4. Substitutions: Permitted in accordance with Division 1
- C. Thermometer: ASTM E1, adjustable angle, solar digital.
1. Stem: 3/4" NPT brass, 3-1/2"
 2. Accuracy: ASTM E77 2%

2.6 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.

2.7 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.

2.8 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.
 - 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.

2.9 PIPE HANGER ACCESSORIES

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

2.10 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.
- 2.11 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.
- 2.12 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. Firestopping Insulation: Glass fiber type, non-combustible.
 - E. Sealant: Acrylic.
- 2.13 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.
- 2.14 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. 1/2 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.

2.15 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 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.

2.17 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 wrap-around 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.
 - 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 the 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 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 gages 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 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 valves in main and branch piping with tags.
10. Tag automatic controls, instruments, and relays. Key to control schematic.
11. 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.
12. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
13. Provide Valve Identification Chart. Post framed chart in Mechanical 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.
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 pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

6. 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 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 220100 and in accordance with the requirements of the Commissioning Agent.

3.3 SCHEDULES

A. Pressure Gauge Schedule:

1. LOCATION:
 - a. Pumps
 - b. Pressure Tanks
 - c. Hot Water Tank
 - d. Water Heaters
 - e. Mixing Valve Inlets and Outlets

B. Stem Type Thermometer Schedule:

1. LOCATION
 - a. Hot Water Tank Outlet
 - b. Water Heater Outlet
 - c. Mixing Valve Inlets and Outlets (All sides)

C. Supports and Hangers:

PIPE SIZE INCHES	MAX. HANGER	SPACING (FT)	HANGER ROD DIAMETER INCHES
	HORIZONTAL	VERTICAL	
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	10	3/8
C.I. Bell and Spigot (or No Hub) and at joints	5	15	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 220100

SECTION 220250 – 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 220010.
- 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

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 WATER AND CONDENSATE PIPING

- A. All aboveground interior storm water (including roof drain bodies) 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.
- 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. Cold Water Pipe – 0.5" thick
 - 2. Hot Water Pipe and Hot Water Recirculation Pipe:
 - a. Up to 1-1/4" pipe size – 1.0"
 - b. 1-1/2" to 4" pipe size – 1.5"

END OF SECTION 220250

SECTION 220410 - 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. Storm Water Piping System
- F. Roof and Floor Drains
- G. Cleanouts
- H. Hydrants and Hose Bibbs
- I. Condensate Piping System
- J. Natural Gas Piping System
- K. Water Hammer Arresters
- L. Backflow Preventers
- M. Interceptors

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
 - 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 220010.
 - 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: Schedule 40 ASTM D2665.

1. Fittings: PVC
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
3. Not for any kitchen drainage piping. Kitchen drainage piping is all drain piping up to inlet of 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 310, hubless, service weight.
 1. Fittings: Cast iron.
 2. Joints: Neoprene gaskets and stainless-steel clamp-and-shield assemblies.
- C. PVC Pipe: Schedule 40 ASTM D2665.
 1. Fittings: PVC
 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
 3. PVC piping is not permitted in any plenums – no exceptions.
 4. PVC is not permitted for any kitchen drain piping – no exceptions.

2.3 WATER PIPING, BURIED

- A. Copper Tubing: ASTM B88, Type K, hard drawn.
 1. Fittings: ASME B16.18, cast bronze or ASTM B16.22 wrought copper and bronze.
 2. Joints: ASTM B32, solder, Grade 95TA.
 3. NSF 61
- B. Cast Iron Pipe: AWWA C151.
 1. Fittings: Ductile iron, standard thickness.
 2. Joints: AWWA C111, rubber basket with 3/4" (19 mm) diameter rods.
 3. NSF 61

2.4 WATER PIPING, ABOVE GRADE

- A. Copper Tubing: ASTM B88, Type L, 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 B 828
 3. NSF 61
 4. Propress Bronze, or Copper pipe fittings are permitted for all pipe sizes.

2.5 STORM WATER PIPING, BURIED

- A. Cast Iron Pipe: ASTM A74 service weight. (Interior)
 1. Fittings: Cast iron.
 2. Joints: ASTM C564, neoprene gasket system.

- B. PVC Pipe: Schedule 40 ASTM D2665
 - 1. Fittings: PVC
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 cement.
- 2.6 STORM WATER PIPING, ABOVE GRADE
- 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.
- 2.7 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.
 - A. PVC Pipe: Schedule 40 ASTM D2665
 - 1. Fittings: PVC
 - 2. Joints: ASTM D2665, solvent weld.
 - 3. PVC piping is not permitted in any plenums – no exceptions.
- 2.8 PUMPED SANITARY AND STORM PIPING, ABOVE GRADE
- A. Sizes 2 inches and smaller:
 - 1. Pipe: Schedule 40 galvanized steel, threaded and coupled, S=ASTM A53
 - 2. Joints: Threaded
 - 3. Fittings: Galvanized cast iron screwed type, ASTM A126, ASTM A153.
 - B. Sizes 2-1/2" and larger:
 - 1. Pipe: Schedule 40 Galvanized steel, beveled ends, ASTM A53
 - 2. Joints: Butt welded and flanged
 - 3. Fittings: Schedule 40 seamless steel, butt weld type, ASTM A234
 - 4. Flanges: 150-lb forged steel, welding neck or slip-on, ASTM A181 Class 60, ANSI B16.5
- 2.9 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.
 - B. Pipe shall be and be installed in accordance with NFPA, International Gas Code, and Gas Company.

- C. Gas regulator vent piping shall be seamless and shall meet the same requirements and specification as natural gas piping.

2.10 NATURAL 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 requirements.

2.11 NATURAL GAS PRESSURE REGULATORS

- A. General Requirements:
 - 1. Single stage and suitable for natural gas
 - 2. Steel jacket and corrosion-resistant components
 - 3. Elevation compensator
 - 4. End Connections: Threaded for regulators 2" and smaller, flanged for regulators 2-1/2" and larger.
- B. Line Pressure Regulators: Comply with ANSI Z21.80:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Actaris
 - b. American Meter Company
 - c. Eclipse Combustion, Inc.
 - d. Fisher Control Valves and Regulators: Division of Emerson Process Management
 - e. Invensys
 - f. Maxitrol Company
 - g. Richards Industries: Jordan Valve Div.
 - 2. Body and Diaphragm Case: Cast iron or die-cast aluminum
 - 3. Springs: Zinc-plated steel
 - 4. Diaphragm Plate: Zinc-plated steel
 - 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 - 6. Orifice: Aluminum; interchangeable
 - 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon

8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150% of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: Refer to Drawings
13. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150% of design discharge pressure at shutoff.
14. Overpressure Protection Device: Factory mounted on pressure regulator
15. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
16. Maximum Inlet Pressure: Refer to Drawings

2.12 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

2.13 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, solder, or threaded ends.
- C. Comply with NSF 61, Section 9

2.14 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

2.15 WATER PRESSURE REDUCING VALVES

- A. Manufacturers:
 - 1. Watts
 - 2. Taco
 - 3. Bell & Gossett
- B. Up to 2": Bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded and single union ends.
- C. Over 2": Cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.16 GAS SOLENOID VALVES

- A. Valves shall be 2-way valve for fuel gas service. Valve shall be 120/1Ø and shall be normally closed. Valve shall be UL, FM and CSA approved for propane and or natural gas service. Valve shall be blocking (shut-off) valve for industrial and commercial burners by ASCO or accepted substitute.
- B. Valve shall be furnished and installed by the Plumbing Contractor. Valve shall be wired by the Electrical Contractor.

2.17 RELIEF VALVES

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

2.18 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.

- 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 watertight 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.
- 2.19 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.
- 2.20 FLOOR DRAIN (FD-2)
- A. Floor drain shall be Z-1727 adjustable floor-drain with anchor flange and 6" x6" square medium duty adjustable satin finish top and inside caulk outlet. Contractor shall install with deep seal P-trap and Proset trap guard. Trap guard shall be compatible with floor drain and sized to match sanitary piping.
 - B. Provide round funnel Zurn Model Z1724 attachment on drains in which pipes are drained into.
- 2.21 FLOOR DRAIN (FD-3)
- A. Furnish and install floor drain Model Z415 as manufactured by Zurn. Unit shall have durable cast iron body, stainless steel adjustable strainer and inside caulk outlet. Contractor shall install with deep seal trap. Provide ProSet Trap Seal or approved equal.
 - B. Provide round funnel Zurn Model Z1724 attachment on drains in which pipes are drained into.
- 2.22 DEEP SINK FLOOR DRAIN (FS-1)
- A. Deep Sink Type Floor Drain shall be Zurn #Z-1902 12" square open top drain, 10" depth, depth cast-iron body with white acid resisting porcelain enamel interior and top, bottom outlet, less seepage pan with loose set cast-iron secondary 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.
- 2.23 ROOF DRAIN (RD-1)
- A. Furnish and install roof drain Model Z-100ERC as manufactured by Zurn. Drain shall have dura-coated cast iron body with extension, roof sump receiver and under deck clamp. Unit shall have combination membrane flashing clamp/gravel guard and low silhouette aluminum dome.

2.24 ROOF DRAIN (ORD-1)

- A. Furnish and install roof drain Model ZURNZ-100-W3 15" diameter roof drain as manufactured by Zurn. Unit shall have dura-coated cast-iron body with combination membrane flashing clamp/gravel guard with 3" internal water dam and low silhouette aluminum dome.

2.25 OVERFLOW STORM SPOUT (OSS-1)

- A. Overflow storm spout shall be Zurn Z199 nickel bronze body storm spout with removable stainless-steel screen. Finish type shall be selected by Architect.

2.26 HOSE BIBB (HB-1)

- A. Hose Bibb shall be Zurn Z-1350 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 supply, key operated control valve, and 3/4" solder inlet and 3/4" male hose connections standard. Stainless steel box and hinged cover with operating key lock and "WATER" stamped on cover. Comply with CSF 61, Section 9.

2.27 WALL HYDRANT (WH-1)

- A. Wall hydrant shall be Zurn Z1300 Encased Ecolotrol "anti-siphon" automatic draining wall hydrant for flush installation. Complete with non-freeze type integral backflow preventer, bronze casing, all bronze interior parts, non-turning operating rod with free-floating compression closure valve, replaceable bronze seat and seat washer, and combination 3/4" [19] female or 1" [25] male straight IP inlet. Nickel bronze box and hinged cover with operating key lock and "WATER" cast on cover. Comply with CSF 61, Section 9.

2.28 WALL HYDRANT (WH-2)

- A. Furnish and install wall faucet Model Z138BFP as manufactured by Zurn. Unit shall be exposed non-freeze anti-siphon dual hot/cold wall faucet complete with automatic draining hose connection backflow preventer, exterior chrome finish, brass casing, all bronze interior parts, operating rod with spring-loaded compression closure valve, replaceable seat washer, combination 1/2" female solder inlet and 1/2" male IP inlet connections standard, and 3/4" male hose connection.

2.29 ROOF HYDRANT (RH-1)

- A. Furnish and install Freezeless Roof Hydrant Model #SRH-MS by Woodford or equal. ASSE 1052 Listed, Unit shall have 3/4" NPT female inlet, Hose connection Dual Check Backflow Preventer Model 50HF with 3/4" brass hose connection ASSE 1052 Listed, 1-1/4" galvanized pipe, No drain required, cast iron hydrant support components with EPDM Boot.

2.30 GREASE INTERCEPTOR (GI-1)

- A. Schier Great Basin™ grease interceptor model # GB-1000 shall be lifetime guaranteed and made in USA of seamless, molded polyethylene with minimum 7/16" uniform wall thickness. Interceptor shall be furnished for above or below-grade installation with adjustable cover adapter and Safety Star® access restrictor built into each cover adapter. Interceptor shall be certified to ASME A112.14.3 (Type D) and CSA B481.1 and IAPMO/ANSI Z1001-2021. Interceptor flow rate shall be 100 GPM or 200 GPM. Interceptor grease capacity shall be 5,495 lbs. @ 100 GPM or 4,959 lbs. @ 200 GPM. Interceptor grease capacity at 99% efficiency shall be 5,272 lbs. @ 100 GPM or 3,127 lbs. @ 200 GPM. Cover shall provide water/gas-tight seal and have minimum 16,000 lbs. load capacity.

2.31 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 charge 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.

2.32 EXPANSION TANK (ET-1)

- A. Furnish and install an expansion tank Model ST-30V-C by Therm-X-Trol. Tank(s) shall be diaphragm type specifically designed for potable water and shall be ASME stamped.

2.33 BACKFLOW PREVENTER

- A. Backflow Preventer shall be Watts Regulator Series 909 or equal with strainer.
- B. Approved equal.

2.34 CONDENSATE PUMPS

- A. Automatic Condensate Unit shall be Hartell Model A2-X-1965 pump or equal with vertical type pump unit, high impact leak-proof, rust-proof cast aluminum tank, tank cover, volute and impeller, stainless steel shaft, auxiliary safety switch to shut down HVAC unit in the event of high water level, check valve, junction box wire connections, thermally protected, UL listed.
- B. Safety switch shall be interlocked with the ATC System. Coordinate with ATC Contractor.

2.35 APPROVED EQUALS

- A. The following are approved equals providing they meet specifications:
 - 1. Drains, Hydrants - Wade, Smith, Ancon, Watts, MiFab
 - 2. Mixing Valves - Powers, Leonard, Symmons, Lawler, and Acorn

2.36 ELECTRIC HEAT TRACING

- A. Electric heat tracing for the purpose of freeze protection shall be installed on condensate piping for cooler and freezer in Kitchen. See Plans.

2.37 ASME ULL BLADDER TYPE EXPANSION TANKS (PST-1)

- A. Manufacturers:
 - 1. Taco, Inc; Model CA 450-125: www.taco-hvac.com
 - 2. ITT Bell & Gossett
 - 3. Amtrol Inc
 - 4. Or approved Equal.
- B. Construction: Welded steel, designed, tested and stamped in accordance with ASME (BPV code sec VIII, div 1); supplied with National Board Form U-1, rated for working pressure of 150 psi, with flexible heavy duty butyl rubber bladder. Bladder shall be able to accept the full volume of the expansion tank and shall be removable and replaceable. Bladder shall be NSF 61 rated for low temperature potable water service and shall be manufactured with FDA approved materials.
- C. Accessories: Pressure gage(field installed in adjacent piping by others) and air-charging fitting ; precharge to 40 psi.
- D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.
- E. Size:
 - 1. CW Tank Capacity: 119 gallons., 61 gallon of acceptance volume.

2.38 MULTIPLEX, VARIABLE-SPEED BOOSTER PUMPS (DWBP-1)

- A. Manufacturers: Subject to compliance with requirements, the pumping system shall be MODEL PR0-22DH07XXX-4H-XX-SWF55-3 as manufactured by Syncroflo, Inc., Norcross, GA, USA. Operating on 208 volt 3 phase 60 Hz power.
- B. Basis of Design Product:
 - 1. SyncroFlo, Inc.
 - 2. Alternate manufacturers seeking authorization to bid shall be registered ISO9001:2015 and shall have a current Quality Management certificate, installation of 200 similar systems that have been in operation for 10 years a comparable product by one of the following may be acceptable:
 - a. Gould's Pumps, ITT Corporation
 - b. Xylem Bell & Gossett
 - c. FloTherm Corporation
 - d. Penn pumps
- C. Description: Factory-assembled and tested, fluid-handling system for domestic water, with pump, piping, valves, specialties, and controls, and mounted on a base.

1. Furnish and install a prefabricated duplex variable speed water pressure booster system model PRO-22DH07XXX-4H-XX-SWF55-3 as manufactured by SyncroFlo, Inc., Norcross, GA, distributed by Matt Jenschke of BJ Terroni Co., Inc., 215-639-3600. The system shall be capable of providing a constant system pressure of 75 psig with flow rates from 0 to 220 GPM when suction pressure is 25 psig minimum using 208-volt, 3 phase, 60 hertz power.
- D. Pumps:
1. Pump shall be NSF certified close coupled end suction design with BULGED FORMED PROCESS 300 series stainless steel construction (Stamped pump casings are not considered equal).
 2. Pumps shall be equipped with sleeve mounted mechanical shaft seals and close-coupled to premium efficiency motors.
 3. Pump designs that do not have shaft sleeves shall not be acceptable. Pump shall be fitted with single component seal.
 4. Close coupled end suction pumps shall be fitted with a mounting foot on the pump volute for additional support.
- E. Motors:
1. Motor shall meet or exceed NEMA MG-1 Table 12-12 for exact motor efficiencies. Motor shall have a service factor of 1.15, ODP, and class F insulation. Incoming electrical service shall be designed for 208-volt, 3 phase, 60 Hz. Motors shall be non-overloading at all points on the curve.
 2. Motors, when coupled to a VFD shall have a 1.0 service factor per NEMA MG-1.
 3. Motor shall be a stocked, standard NEMA frame size and shall not include thrust bearings.
- F. Piping
1. All pipes shall be 304L stainless-steel with welded ASME B16.5 flanged connections rated for the system pressure.
 2. All branches shall be mechanically formed with the T-Drill process or equal. Piping fabricated with saddle cut branches will not be acceptable.
 3. The final outlet height shall be produced by beveling or facing so as to provide the required fit-up and have the same flow characteristics of an ASME tee fitting.
 4. Welding of the branches shall be by the TIG process with the interior of the pipe protected from oxidization by back-purge with inert gas.
 5. All component connections shall be made with ASME flanges in accordance with ASME B16.5 and shall be welded to the headers via the GMAW process with the correct filler wire. The use of threaded or grooved fittings is not permitted.
- G. Valves
1. Isolation Valves: NSF-61 certified, lug-type butterfly valve with lever handle, valve shall be rated for operation at maximum system pressure plus suction pressure. Valves shall be mounted on the suction and discharge of each pump. Valves shall be rated for a minimum of 200 PSIG working pressure. Threaded gate or ball valves shall not be considered equal.
 2. Check Valve: NSF certified, silent type in pump discharge piping.
 3. Thermal-Relief Valve: Mechanical temperature relief valve in pump discharge piping

- H. Base Plate:
1. Baseplate shall be 300 series stainless-steel, formed by mechanical process to a groutable channel with end caps. Baseplates of carbon steel shall not be permitted.
 2. A removable panel stand constructed of galvanized metal framing strut bolted to the baseplate.
 3. Baseplate shall have 4 anchor points.
- I. Power and Control Panel: Factory installed and connected as an integral part of booster pump; automatic, variable-speed operation, with load control and protection functions. A two dimensional barcode or QR code label shall be applied to the inside door of the control panel through which the system operation & maintenance manual and other system information can be access through a hand held device.
- J. The PLC, HMI and VFDs shall be warrantied for a period of 5 years by a third party.
1. Enclosure:
 - a. Nema 12
 2. Programmable Logic Controller (PLC)
 - a. A Mitsubishi PLC shall be installed on the control panel base pan, not the door, to protect it from damage. The PLC manufacturer shall be clearly marked on the controller and shall be non-proprietary.
 - b. The PLC shall continue to function even if the touchscreen is broken, damaged, or removed.
 - c. The PLC shall have the following features: 32,000 steps of built-in program memory, 7680 auxiliary relays, 320 timers, 235 counters, 8000 data registers, 24,000 extension registers, and 24,000 extension file registers
 - d. The PLC shall control all pump starts and stops and indicate all alarms thru Human Machine Interface.
 - e. Nonvolatile EEPROM memory to prevent program loss due to power failure.
 - f. Program cartridge or loader which allows program changes to be made by the factory and sent to the field for simple loading by the operator.
 - g. Input and output "on" status lights for ease of monitoring.
 - h. Controller shall be designed for use in locations where electromagnetic noise, voltage spikes, 32 - 130° temperature, 35 - 85% humidity, and mechanical shock within the range certified by JIS 0912 exist.
 3. Human Machine Interface (HMI)
 - a. An HMI shall be flush mounted on the door of the control panel.
 - b. The HMI shall be rated UL Type 4.
 - c. The HMI shall have a 320 x 240 resolution, 256 color, 5.7" screen, 520 characters/screen, 300 touch points/screen
 - d. The following data shall be accessible through the HMI:
 - 1) System status including current system pressure and setpoint, pump run status, the current speed of the pumps (Hz) and the method of speed control. Display active system alarms on all user screens.
 - 2) Usage history shall record, along with the date and time, pump starts, and pump run hours. Usage history may be reset.
 - 3) A Set Points Menu system for adjusting setpoints. Display and adjust system pressure, VFD speed, power, minimum speed, lead pump shutdown mode, and tank pressurizer set points and time delays. Restore

- to either factory defaults or the last saved field defaults. Protect adjustable settings with a password.
- 4) Alarm History of the past 200 alarms. Each log shall include individual pump run status, system pressure and run setpoint, alarm type and the date and time. Alarm Type shall be in plain English, not codes requiring a reference list.
 - 5) Alarm List of all possible alarms and their current status. Display any current alarms on all user screens.
 - 6) Startup instructions and checklist.
- e. The HMI shall include a method for transferring data.
- 1) System information shall automatically copy to an installed SDHC card every minute, plus an additional entry for each alarm.
 - 2) Include fault codes from the PLC and VFD.
 - 3) Copy usage data to the card daily.
- f. Data shall be stored in a text file, readable by non-proprietary software.
- 1) HMI software shall allow for program changes to the HMI to be transferred via the SDHC card.
 - 2) Pump selector switch shall be provided on the HMI with the following positions:
 - a) HAND: Use for manual operation only - to start up, restart and reset or test each pump. No pump should run in this position without supervision.
 - b) OFF: Pump will not run at all. Use during start up, restart and reset, or when a pump is down for service.
 - c) AUTO: Automatic position for each pump, which allows the controller to have full control over the pump's operation.
 - 3) Alarms
 - a) Low Suction Pressure \ Level Alarm: The low suction device (pressure transmitter or level switch) signals a loss of supply water pressure for 10 seconds (default), all pumps will be locked off. This alarm is disabled in the event of a suction pressure transmitter failure. This alarm requires manual resetting (default) or can be set to auto-reset through the HMI.
 - b) Low System Pressure Alarm: If system pressure drops to or below the low system pressure set point for 30 seconds (default), this alarm will activate. System performance will not be affected by this alarm. It is used to alert the operator that a problem occurred. This alarm will be disabled in the event of a system pressure transmitter failure. The alarm requires manual resetting.
 - c) Low-Low Suction Pressure Alarm: When active (default) this alarm aids in recognizing substantially low system pressure. This is designed to help recognize catastrophic failures. When this abnormally low set point (defaulted 30PSI below set point) is reached for preset period of time (defaulted at 60sec) the system shall go into alarm and shut down. The system will have to be manually reset prior to resuming regular operation.
 - d) Pressure Transmitter Out of Range Alarms: The correct output range of the pressure transmitter(s) is 1 - 6 kHz. The pressure

- transmitter failed low alarm will activate if the controller receives an abnormally low signal for 2 seconds. The pressure transmitter failed high alarm will activate if the controller receives an abnormally high signal for 8 seconds. The system will run at the manual speed set point if the system pressure transmitter fails.
- e) Individual Drive Fault Alarms: If a fault occurs in the drive when it is being called to run, the VFD failure alarm will be activated. This alarm will stop the pump with the failed drive and start the next available pump if it is not currently running. The alarm requires manual resetting with the alarm silence / reset push button.
 - f) Irregular Power Alarm (optional): If a power monitor is included with this system, it will protect the system from an abnormal main power condition. If irregular power is sensed, the system will shut down all motors until normal power has been restored for 10 seconds.
 - g) Alarm Combinations: If multiple alarms occur, the controller will indicate all alarm conditions by continually scrolling them on the HMI. The alarm silence/ reset push button can be pressed to stop the scrolling.
 - h) Resetting Alarms: Each of the alarms (except Pressure Transmitter Out of Range and Irregular Power) requires manual resetting before returning to normal automatic operation. This ensures proper troubleshooting problem solving, and a smooth return to normal automatic operation by the operator. Before resetting an alarm, the alarm horn must first be silenced by pressing the alarm silence / reset push button. Five seconds after silencing the alarm horn, the system can be reset (provided the original reason for the alarm has been corrected).
 - i) Event History: This feature displays the last 200 events that have occurred on the system with record 0 being the most recent. An event is when any alarm occurs, or the operator attempts to reset an alarm with the alarm reset push button.
- 4) Protection Devices
- a) Operator Safety: The enclosure features a door-interlocking motor disconnecting device (un-fused disconnect switches, or circuit breakers). These prevent the opening of the panel while the motors are running. All wiring shall be touch safe.
 - b) Motor and VFD Protection: Each VFD shall be protected against overload and short circuit current by fused disconnects, which fail safe.
- 5) Remote Indication
- a) Discrete Outputs: Indication of the low system pressure alarm, low-low system pressure alarm, the low suction pressure/ level alarm, high system pressure, and pump disabled is provided.
- 6) Pressure transmitters
- a) Digital pressure transmitters shall be connected to the system suction and discharge headers. The transmitter shall have 1.0% accuracy, stainless steel wetted parts and a waterproof enclosure.

Transmitter shall be capable of withstanding over pressurization of double its range. Pump system shall be capable of calibrating the zero setting in the field.

K. Variable Frequency Drives

1. Each pump shall have its own Mitsubishi variable frequency drive with the following features:
 - a. Voltage source, GTR or IGBT power transistor-based inverter - PWM Type
 - b. Use a high carrier frequency to reduce drive and motor noise
 - c. Shall be capable of operating in an ambient temperature between 15 degrees F and 100 degrees F and a line voltage variation of less than 10 percent.
 - d. Self-protection features shall include under voltage and over voltage protection, current overload protection, short circuit protection, power failure protection, ground fault protection, and over-temperature protection.
 - e. Include a four-digit LED readout to indicate the following: drive enabled, output frequency, and all VFD fault conditions.
 - f. The drive shall automatically restart after any of the following: overload over-voltage, converter over-current, inverter over-current, or power failure.
 - g. The following drive parameters shall be user adjustable: acceleration speed (1 to 300 seconds), deceleration speed (1 to 300 seconds), minimum speed, and maximum speed.
 - h. The drive shall have the capabilities to provide "HAND-OFF-AUTO" functionality and a digitally encoded dial for adjusting the drive speed while in the "HAND" position.
2. The VFD shall use the following energy saving techniques.
 - a. Slows down the motor
 - b. Reduce current
 - c. Reduces voltage
 - d. Evaluates 6 motor characteristics to further increase efficiency.
3. The VFD shall communicate with the PLC with a DIGITAL connection, with the following capabilities:
 - a. Able to modify 300 different VFD parameters through the PLC and HMI
 - b. Read all VFD data and communicate it to the PLC, HMI, and write to the compact flash drive.
4. VFD Dust Protection
 - a. Install variable frequency drives inside a NEMA 12 control panel. The panel shall include fans to cool the control panel's internally mounted VFD's. Fans shall produce positive cabinet pressure to prevent dust infiltration. Filter all incoming air.
5. VFD Wiring
 - a. Power wiring from the VFDs to the electric motors shall be with a shielded VFD cable with the following features
 - 1) Industrial grade PVC jacket
 - 2) Industrial grade XLPE insulation
 - 3) Ground and shielding system to minimize radiated and conducted noise

L. Pump Sequencing and Operation

1. The lead pump will start on a low system pressure condition. The lead pump shall run continuously if selected by the operator. The lag pump(s) will sequence based on a combination of system pressure, high lead pump speed, and power usage. This combination of parameters will ensure the starting of the lag pumps as the running pump(s) come to full capacity. System pressure is continuously maintained by adjusting the speed of the pump(s).
 2. Automatic sequencing shall include the following features:
 - a. Power sequencing, programmable in horsepower not Watts.
 - b. Pressure sequencing.
 - c. End-of-curve protection, based on pump differential, with 2% accuracy
 - d. VFD speed sequencing
 - e. Lead pump shutdown feature that can be enabled or disabled by the operator
 - f. Low-flow test feature testing pressure, power, VFD speed, and flow (if equipped with flow sensor), to reduce pump short-cycling, pressure swings, power surges, and motor wear.
 - g. Tank pressurization sequence to increase the energy stored in the tank prior to shutdown
 - h. Time clock to disable lead-pump shutdown during building occupancy.
 - i. Sequence shifting that adjusts the pump sequence when any pump is disabled
 - j. Successive and 24-hour alternation of equal capacity pumps
 - k. Pump overlap during 24-hour alternation
 - l. Lag pump exerciser function
 - m. Special sequencing to reduce surges during power restoration
 - n. Sequential sequencing of lag pumps
 - o. Minimum run and stop delay timer for each pump
 - p. Field adjustable time delay for lag pump pressure start signals
 - q. Field adjustable low suction pressure alarm Field adjustable selection to enable / disable limited auto reset of low suction, high system pressure alarms, and VFD fault.
 3. Manual speed control
 - a. If the system pressure transmitter fails or the operator chooses, the controller will output a constant speed value to the drive, which can be adjusted by the operator using the HMI.
- M. Instrumentation and Emergency Controls
1. Provide pressure sensors for high system pressure, low system pressure, and low suction pressure conditions. All pressure sensors shall be control panel mounted.
 - a. Digital pressure transmitters shall be connected to the system suction and discharge headers. The transmitter shall have 1.0% accuracy, stainless steel wetted parts and a waterproof enclosure. Transmitter shall be capable of withstanding over pressurization of double its range. Pump system shall be capable of calibrating the zero setting in the field.
 2. Provide individual NSF certified 2½", stainless steel, glycerin-filled pressure gauges for each pump, system, and suction pressures.
 3. A temperature relief valve shall be mounted in directly on the pump casing for a fast, accurate response.

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, on inside and outside, before assembly.
- D. Prepare piping connections to equipment with flanges or unions.
- E. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster pump installation.

3.2 INSTALLATION

- A. Booster Pump Installation
 - 1. Install pump system on a suitable concrete pad.
 - 2. Include a floor drain sized according to local code. Drain shall provide emergency drainage to prevent building damage in the event of seal failure, over- temperature, or tank discharge.
 - 3. Anchor pump system in accordance with system manufacturer's recommendations.
 - 4. Pipe temperature relief valve discharge to drain
 - 5. Install isolation valves on each header.
 - 6. Pipe pumping systems bypass line with isolation valve.
 - 7. All field anchoring, piping, and wiring shall comply with local codes.
 - 8. Install piping adjacent to booster pumps to allow service and maintenance.
 - 9. System skid shall be grouted into place to minimize vibration and eliminate potential skid deformation.
- B. Install in accordance with manufacturer's instructions.
- C. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- D. Route piping in orderly manner and maintain gradient.
- E. Install piping to conserve building space and not interfere with use of space.
- F. Group piping whenever practical at common elevations.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. Provide clearance for installation of insulation and access to valves and fittings.
- I. Provide access where valves and fittings are not exposed.

- J. Establish elevations of buried water piping outside the building to ensure not less than 3' of cover.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Provide support for utility meters in accordance with requirements of utility companies.
- M. Install bell and spigot pipe with bell end upstream.
- N. Install valves with stems upright or horizontal, not inverted.
- O. Install unions downstream of valves and at equipment or apparatus connections.
- P. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- Q. Install ball valves for throttling, bypass, or manual flow control services.
- R. Provide flow controls in water recirculating systems where indicated. Flow control valves shall be Bell & Gossett Circuit Setters or equal.
- S. 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.
- T. Slope water piping and arrange to drain at low points.
- U. Cleanouts shall be installed where indicated on the drawings and at all bends, angles, upper terminals, base of stacks and not over 50' apart in any lineal run of piping. All cleanouts shall be accessible.
- V. All horizontal sanitary vent piping shall be sloped.
- W. All underground sanitary piping shall be minimum 2" size.
- X. Water hammer arrestors shall conform to ASSE 1010.
- Y. All changes of direction shall be made with fittings per IPC (International Plumbing Code).
- Z. 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.
- B. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.
- C. Adjust pressure set points.
- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to 1 visit to project during other than normal occupancy hours for this purpose.

3.5 STARTUP SERVICE

- A. Engage a factory authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 DEMONSTRATION

- A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain booster pumps.

3.7 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.

3.8 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.
- E. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- F. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- G. Tests and Inspections:
 - 1. Perform visual and mechanical inspection.
 - 2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- H. Pumps and controls will be considered defective if they do not pass tests and inspections.
- I. Prepare test and inspection reports.

END OF SECTION 220410

SECTION 220440 - PLUMBING FIXTURES & EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Water Closets
- B. Urinals
- C. Lavatories
- D. Electric Water Coolers
- E. Carriers
- F. Showers
- G. Water Heaters
- H. Domestic Hot Water Circulating Pumps
- I. Ice Maker Connection Box
- J. Washing Machine Box
- K. Sinks

1.2 REFERENCES

- A. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.
- B. ANSI/ARI 1010 - Drinking-Fountains and Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers.

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 220010.
- B. Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

PART 2 - PRODUCTS

2.1 LAVATORY (LV-1)

- A. Furnish and install wall hung American Standard Lucerne Lavatory Model #0355.012. Unit shall be vitreous china with front overflow, back and side splash shields, "D" shape bowl and faucet holes suitable for concealed arms. Faucet shall be Sloan Optima Model EBF-650-8, infrared sensor, battery powered electronic faucet, 0.5 gpm, ADA, below deck mixing valve, centerset faucet for 4" centers. Faucet shall be equipped with a flow restricter and aerator. 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. Comply with NSF 61, Section 9.
- B. Furnish and install with lav-shield as manufactured by Tru-Bro. use tamperproof screws.
- C. Provide mixing valve (MV-1), Powers HydroGuard Series LM495 thermostatic mixing valve (or equal).
- D. Mount at height as shown on the architectural drawings.

2.2 LAVATORY SYSTEM (LV-2)

- A. The modular multiple lavatory system shall be Bradley 2-Station (as shown) Express Model #SS-Z/IR. Multiple lavatory system shall provide 2 hand washing station with the center line of each station located on 30" centers, perpendicular to the mounting wall. Each standard height hand washing station shall comply with ANSI and ADA accessibility standards.
- B. Bowl material for each station shall be a cast polyester resin complying with ANSI Z124.3 and ANSI Z124.6. Bowl finish shall be decorative stone. Bowl color shall be special colors selected by Architect. See ID Schemes.
- C. Lavatory stations shall be secured to a rigid-base concealing all supply and waste connections.
- D. Base shall support all hand washing stations to ANSI Z124.3 load ratings. Each hand washing station shall have a streamformer served by an independent solenoid valve and actuated by an infrared sensing module with two zone-focused transmitting beams not exceeding the bowl perimeter. Each sensor shall have a 2-3 second turn-off delay; and automatic shut-off after 30-45 seconds of continuous operation. Maximum 0.5 gpm.
- E. Lavatory system shall include all waste and supply connections to wall, and thermostatic mixing valve with stop, strainer, and check valves.
- F. Furnish with transformer and liquid soap dispenser.
- G. Provide mixing valve (MV-1), Powers HydroGuard Series LM495 thermostatic mixing valve (or equal).

2.3 SHOWERS (SH-1)

- A. Furnish and install Delta Commercial Shower Units as follows:
 - 1. SH-1: T13H-1-5-2. Unit shall include pressure balance thermostatic valve with diverter, standard brass shower head, hand shower with hose, slide/grab bar, and ADA handle. Shower shall be ADA compliant.
- B. All Showers (SH-1) shall include a Floor drain (FD-1) which shall be furnished and installed by the Plumbing Contractor.

2.4 HAND SINK (HS-1)

- A. Furnish and install wall hung American Standard Lucerne Lavatory Model #0355.012. Unit shall be vitreous china with front overflow, back and side splash shields, "D" shape bowl and faucet holes suitable for concealed arms. Faucet shall be Elkay Model # LK406GN04T4 , 4" Center set with Exposed Deck Faucet with 4" Gooseneck Spout 4" Wristblade Handles Chrome. Faucet has a flow rate of 1.5 GPM, and is made of Chrome-plated Brass material, with a Quarter Turn Ceramic Disc valve. Faucet requires 2 faucet holes. 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. Comply with NSF 61, Section 9.
- B. Furnish and install with lav-shield as manufactured by Tru-Bro. use tamperproof screws.
- C. Provide mixing valve (MV-1), Powers HydroGuard Series LM495 thermostatic mixing valve (or equal).
- D. Mount at height as shown on the architectural drawings.

2.5 SINK (SK-1)

- A. Furnish and install Elkay stainless steel compartment Lustertone Sink Model #LRAD2219 with 3 holes on 4" center, (5-1/2" deep ADA). Faucet shall be Delta #26C3944 cast deck mount faucet with 3" centers, 3 lever blade handles, heavy duty 6" gooseneck spout, aerator and 1.5 gpm flow restrictor, sink shall include drain with strainer and tailpiece, unit shall be supplied with McGuire #169 flexible supply pipes and McGuire #8872 adjustable P-trap. Installation shall be ADA compliant.

2.6 SINK (SK-2)

- A. Furnish and install Elkay stainless steel double compartment Lustertone Sink Model #LRAD-3319 with 3 holes on 4" centers, 5-1/2" deep ADA bowl with off center drain. Faucet shall be Delta #26C3944 cast deck mount faucet with 3" centers, 3 lever blade handles, heavy duty 6" gooseneck spout, aerator and 1.5 gpm flow restrictor. Sinks shall include drain with strainer and tailpiece. Units shall be supplied with McGuire #169 flexible supply pipes and McGuire #8872 adjustable P-trap. The sink shall be ADA compliant.

2.7 ART SINK (SK-3 & SK-4)

- A. The art sinks shall be integral to the countertop and shall be furnished and installed by the General Contractor.
- B. The plumbing contractor shall furnish and install, Faucet shall be Delta #26C3944 cast deck mount faucet with 3" centers, 3 lever blade handles, heavy duty 6" gooseneck spout, aerator and 1.5 gpm flow restrictor. Sinks shall include drain with strainer and tailpiece. Units shall be supplied with McGuire #169 flexible supply pipes.
- C. Include SK-3 & SK-4 in Art Room: With Solids Interceptor (CT-1), Zurn ZA1180, in lieu of P-trap.

2.8 WATER COOLER (EWC-1)

- A. Furnish and install Halsey Taylor HydroBoost Bottle Filling Station, & Bi-Level ADA Cooler, Model HTHB-HACG8BLSS-WF, High Efficiency Filtered, refrigerated stainless steel, chilling capacity of 8 GPH Stainless. Chilling Capacity of 8.0 GPH (gallons per hour) of 50°F drinking water, based on 80°F inlet water and 90°F ambient, per ASHRAE 18 testing. Features shall include Hands-Free, High Efficiency, Green Counter, Laminar Flow, Antimicrobial, Real Drain. Furnished with Double Bubbler. Electronic bottle filler sensor with mechanical front and side bubbler pushbar activation. Product shall be wall mount (on-wall), for indoor applications, serving 2 station(s). unit shall be certified to UL 399 and CAN/CSA C22.2 No. 120. Unit shall be lead-free design which is certified to NSF/ANSI 61 and 372 (lead-free) and meets Federal and State low-lead requirements. Furnish and install with Model #98324C Cane Apron.

2.9 MOP RECEPTOR (MB-1)

- A. Mop receptor shall be Model MSB- 2424 as manufactured by Powers Fiat, Skokie, IL or equal. Color shall be No. T31 - White Drift. The drain body shall be factory installed stainless steel #302 with combination strainer and lint basket. Faucet shall be Chicago Model 897-RCF service sink faucet, renewable seats, lever handles, 3/4" threaded hose and spout bucket hook top brace to wall, vacuum breaker, union inlets, adjustable 8" centers, 2" female thread, rough 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. Provide and install hose bibb beside mop sink for connection to chemical cleaning system. Installation shall consist of single faucet with vacuum breaker and 3/4" thread hose coupling. Field coordinate exact location with owner prior to installation.

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

- A. Furnish and Zurn Wall Hung Top Spud Toilet Model #Z-5615-BWL. Unit shall be vitreous china with siphon jet action, elongated bowl, 1-1/2" back spuds, and bolt caps. Unit shall be supplied with Church #5321.112 open front seat Sloan Regal 111 SFSM, battery, infrared exposed sensor 1.6 GPF water closet flush valve and carrier. Mount at height as shown on the architectural drawings. WC-1 shall be ADA compliant and installed at ADA height.

2.11 URINAL (UR-1, UR-2)

- A. Wall mounted urinal ZURN model Z5755-U 0.125 gpf to 1.0 gpf vitreous china, wall hung, integral trap, washdown urinal complete with 3/4" top spud connection, 2" outlet connection and vandal resistant outlet strainer. Regal 186 SF5M-1.0, battery, infrared exposed sensor 1.0 GPF Urinal flush valve, and wall hanger. Mount at height as shown on Architectural drawings. Urinal (UR-1) shall be ADA compliant.

2.12 WASHING MACHINE CONNECTION (WMB-1)

- A. Furnish and install washing machine connection unit. Fixture shall be by Gray Manufacturing Co., Inc. Model FB200 with 1/2" combination MPT brass sweat connections and 2" drain. Unit shall be for recessed installation and shall be provided with top or bottom supplies as required.

2.13 ICE MAKER CONNECTION BOX (IMB-1)

- A. Furnish and install Guy Gray Metal Ice Maker Box Model 2B with quarter turn valve, outlet, box, faceplate, and white powder coat finish.

2.14 DOMESTIC HOT WATER CIRCULATING PUMP (CP-1, CP-2)

- A. Furnish and install domestic water circulating pumps. The pump shall be all stainless steel 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. Comply with NSF 61, Section 9.
- 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. The pump shall be Taco #2400 circulating pump or approved equal by Bell & Gossett. Pump CP-1 shall have a capacity of 20 GPM @ 35' head and shall be 1/8 hp, 115V, 1Ø. Pump CP-2 shall have a capacity of 10 GPM @ 15' head and shall be 1/8 hp, 115V, 1Ø. The pumps shall be controlled by a strap-on thermostat.
- E. The system shall be provided with a bronze balancing valve and bronze shutoff valves for flow adjustment and maintenance.

2.15 FOOD SERVICE FIXTURES

- A. Fixtures provided and installed by Kitchen Supplier. Plumbing Contractor shall make all water and drain connections as required. All exposed piping shall have chrome finish. Refer to Drawings for Kitchen Equipment Schedule and for additional work.

2.16 APPROVED EQUALS

- A. The following are approved equals providing they meet specifications:
 - 1. Water Closets, Urinals, Lavatories: Sloan, American Standard, Bradley
 - 2. Faucet: Sloan, American Standard, Chicago, Speakman, Moen Commercial, T&S Brass
 - 3. Water Heater: Rheem, HTP
 - 4. Water Softening System: Marlo Inc., Culligan

2.17 DOMESTIC WATER HEATERS (DWH-1)

- A. Furnish and install Intellihot Model iN501 Water Heaters or approved equal.
- B. General: The water heating plant shall have a recovery of 576 GPH at a 100°F temperature rise. Each water heater shall be ETL Listed; ASME Section IV (HLW) coded and stamped and shall incorporate a negative Pressure gas valve on each exchanger capable of full fire operation at of 2.5" WC of Gas pressure. Each unit shall achieve a minimum turn down of 8.3 per 250,000 BTU of input . The total water content in the system shall be less than 2 Gallons per 250,000 BTU/hr of input. System shall consist of a quantity of 2 Water Heaters Model: iN501 each with an input of 500 MBH, output of 470 MBH, 564 GPH, (7.6 GPM) at 40-140 °F when fired with natural gas, turndown ratio 13.3:1, CO emissions of less than 400 PPM.) 2 – 250MBH (approx.) Heat Exchangers.
- C. Description: Water heater shall be direct fired, fully condensing, water-tube design. Power burner shall have full modulation. The minimum firing rate shall not exceed 30,000 BTU/HR input. Water heaters that have an input greater than 30,000 BTU/hr at minimum fire will not be considered equal. The water heater shall have the capability of discharging into a positive pressure vent. Water heater thermal efficiency shall increase with decreasing load (output), while maintaining set point. Water heater shall have an operational set point capability of 100 °F to 190 °F and shall maintain the outlet temperature within an accuracy of +/- 4 oF during load changes of up to 30% rated capacity. Water heater shall be factory-fabricated, factory-assembled and factory-tested, water-tube condensing water heater with heat exchanger sealed pressure-tight, built on a steel base, including a sealed insulated sheet metal enclosure that acts as combustion-air intake plenum with a built in serviceable air filter.
- D. Heat Exchanger: The heat exchanger shall be constructed with 316L stainless steel helical water tube, fully floating with no welded joints in the exchanger. The exchanger will have a single-pass unitary design (no separate primary and secondary heat exchanger). The water tubes shall be 0.75" ID, with no less than 0.0472" wall thickness. The heat exchanger shall be ASME Sect IV (HLW) stamped for a working pressure not less than 160 psig.
- E. Modulating Air/Fuel Valve and Burner: The water heater burner shall be capable of a – 16.6-to-1, turndown ratio of the firing rate without loss of combustion efficiency or staging of gas

valves. The burner shall be stainless fiber mesh covering a stainless steel body with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. A variable frequency drive (VFD), controlled pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

- F. The exhaust manifold shall be of polypropylene with a 4" diameter.
- G. Ignition: Ignition shall be via spark ignition with 100 percent main-valve shutoff and dual electronic flame supervision.

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.

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 220440

SECTION 220800 – 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:
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.
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.
- 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 220800

SECTION 230010 – 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. VAV Boxes (V)
 - 2. Fan Powered VAV Boxes (FPV)
 - 3. Indoor Air Handling Units (AHU)
 - 4. Kitchen Hood Exhaust Fan and Make-up Air System
 - 5. Indirect Gas-Fired Make-up Air Units
 - 6. Ductless Air Conditioners Split Systems
 - 7. Ductwork
 - 8. Diffusers, Registers & Grilles
 - 9. Exhaust Fans
 - 10. Cabinet Heaters
 - 11. Unit Heaters
 - 12. Wall Heaters
 - 13. Boilers
 - 14. Water Treatment System
 - 15. Hot and Chilled Water System Including Pumps, Piping, Etc.
 - 16. ATC Control System

1.3 UNIT PRICE ITEMS

- A. Refer to Section 012129 and 012200

1.4 DEFINITION OF WORK RESPONSIBILITY

- A. All electrical control components including starters required for operation of HVAC and plumbing equipment whether integral or remote shall be furnished and installed under this

Contract. Control wiring, conduits and accessories for control devices shall be furnished and installed by the Contractor who provides the HVAC and plumbing equipment.

- 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 base flashing, where required, shall be by others, with necessary counter-flashing by this contractor.
- F. All structural work needed for support of mechanical equipment or components shall be supplied by this contractor.
- G. All concrete pads necessary for the support of HVAC and plumbing equipment or components shall be supplied by the contractor who provides the HVAC and plumbing equipment.
- H. All access panels in finished walls or ceilings shall be supplied by this contractor for installation by the General Contractor.
- I. 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.
- J. Refer to the electrical specification section 260180, Coordination of Responsibilities.

1.5 RULES AND REGULATIONS

- A. Perform in accordance with the rules and regulations of the International Building Code (IBC), International Mechanical Code (IMC), International Energy Conservation Code (IECC), 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.

1.6 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. Refurbishment - Disassemble existing equipment and reassemble to its original factory condition by means of cleaning the equipment and replacing missing, damaged or worn components.
- G. Furnish - The term furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.
- H. 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.
- I. Provide - The term provide means to furnish and install, complete and ready for the intended use.

- J. Contractor - The Contractor, Heating Contractor, HVAC Contractor, HC, Mechanical Contractor or MC - The terms mean the Contractor responsible for all work under this Division.
- K. 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 are 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.
- L. 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.
- M. 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.
- N. AHJ – Authority Having Jurisdiction
- O. 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. ASHRAE American Society of Heating, Refrigeration and Air-Conditioning Engineers
 2. ACI American Concrete Institute
 3. ADA Americans with Disabilities Act
 4. AISC American Institute of Steel Construction
 5. AISI American Iron and Steel Institute
 6. ANSI American National Standards Institute
 7. ASTM American Society for Testing and Materials
 8. AWS American Welding Society
 9. CRSI Concrete Reinforcing Steel Institute

- | | | |
|-----|------|---------------------------------|
| 10. | ETL | ETL Testing Laboratories Inc. |
| 11. | ISA | Instrument Society of America |
| 12. | NEC | National Electrical Code |
| 13. | NFPA | National Fire Protection Assoc. |
| 14. | UL | Underwriters Laboratories, Inc. |

- P. 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 | |
| 4. | OSHA | Occupational Safety and Health Administration (US Department of Labor) |
| 5. | 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, 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.

1.8 SUBMITTAL OF SHOP DRAWINGS FOR REVIEW

- A. The Contractor shall submit, with a letter of transmittal to the Architect, six (6) sets of shop drawings 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.
- C. 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.
- D. 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.
- E. None of the items listed under Section 1.2 shall be installed until final approval has been given by the Architect.
- F. Identify Project, Contractor, Subcontractor, or supplier; pertinent drawing and detail number and specification section number, as appropriate on shop drawings.
- G. 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.
- H. On shop drawings, provide space for Contractor and Architect/Engineer review stamps.
- I. Contractor 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 specification. Contractors will be responsible to insure 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.
- 1.9 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. 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 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.
- 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 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.

1.12 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.

1.13 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.

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 the best practices of the trade by qualified and competent tradesmen. Install all equipment in accordance with Engineer's approved shop drawings and manufacturer's recommendations.
- B. Firmly support and secure to the building structure all materials and equipment. Use only approved hardware and methods as described in these Specifications.

1.17 PROTECTION OF EQUIPMENT AND MATERIALS

- 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 and damage.
- C. 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.

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.
- 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 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. Provide through-penetration firestopping for work of this contract; refer to Specification Section 23 0100 for firestopping materials.
 - 3. Any patch work not deemed suitable by the Architect, Owner or CM will be replaced at the expense of the related Contractor.

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.

1.26 ACCESS

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

1.27 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.

1.28 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.

1.29 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.

1.30 GENERAL NOTE

- A. The HVAC Contractor shall replace air filters in all new equipment at the completion of the project.
- B. 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. Temporary filters shall be minimum MERV 13
- C. Provide functional testing for all HVAC equipment. Contractor shall complete and submit Mechanical Equipment Checkout sheet for each HVAC Unit, which can be found at the end of this specification section. Functional testing shall be completed by the HVAC Contractor together with his ATC Sub-Contractor in the presence of the Owner and Engineer.

- D. 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.
- E. All mechanical equipment shall bear the label of an approved agency.
- F. All mechanical equipment shall be installed in accordance with the manufacturers' installation instructions which shall be available at job site.
- G. All roof mounted equipment requiring maintenance or service shall be located a minimum of 10 feet from any roof edge. Any roof mounted equipment mounted less than 15 feet from any roof edge shall include a means for those serving equipment for safety tie off meeting the requirements of OSHA.

1.31 ATTIC STOCK

- A. 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. Furnish one replacement set of filters for all HVAC equipment including dust collection equipment and room air cleaners. A chart shall be provided indicating filter sizes and related HVAC equipment.
 - 3. Furnish one spare set of belts and bearings for each belt driven unit.
 - 4. One gasket kit and one extra set of seals for each pump.
 - 5. One set of couplers for each new pump.

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.
- C. All equipment on roof shall be secured to roof supports. Unfastened equipment is not acceptable.

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.
- 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 air-tight 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 ACCESS PANELS

- A. Removable panels shall be located so as 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.

3.7 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.

3.8 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.

3.9 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.

3.10 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.

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 EQUIPMENT CHECKOUT SHEET

- A. See sheet attached.

END OF SECTION 230010

MECHANICAL EQUIPMENT CHECKOUT SHEET

DATE: _____

UNIT/ROOM # _____

O.A. TEMP: _____

RTHP ☐ HP ☐ AHU ☐ 100% Make-Up Air Unit ☐ DOAS ☐ EF ☐

SPACE TEMP	FAN STARTS	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	O.A. DAMPER CLOSED	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	FAN STARTS	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>

WARMUP	R.A. DAMPER OPEN	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	RELIEF DAMPER CLOSED	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	HEAT VALVE MODULATES OPEN	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>

OCCUPIED HEAT	O.A. DAMPER TO MIN. POSITION	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	R.A. AND RELIEF MOD. PRO-PORTIONAL TO O.A. DAMPER	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>

OCCUPIED COOL H/W VALVE	MOD. CLOSED	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	O.A. DAMPER MOD. OPEN	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	R.A. & RLF MOD. PROP. TO O.A.	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>

UNOCCUPIED FAN STOPS	O.A. DAMPER CLOSED	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	R.A. DAMPER OPEN	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>

FAN CYCLE & H/W VALVE	MOD OPEN TO MAINTAIN	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	SETBACK TEMP	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>

FREEZE CONTROL	FAN STOPS	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	O.A. DAMPER CLOSSES	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	HEAT VALVE OPEN	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>

FIRE/SMOKE CONTROL	FAN STOPS	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>
	O.A. DAMPER CLOSSES	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>

DISCHARGE AIR TEMP HEATING _____ COOLING _____

RETURN AIR TEMP HEATING _____ COOLING _____

NOTES:

TECHNICIAN _____ OWNER REP. _____ DATE _____

FILTER ACCESS	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>	COMMENT
MAINTENANCE ACCESS	YES	<input type="checkbox"/>	NO	<input type="checkbox"/>	COMMENT

SECTION 230100 - MECHANICAL 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. Single Phase Electric Motors
- I. Three Phase Electric Motors
- J. Nameplates
- K. Tags
- L. Stencils
- M. Pipe Markers
- N. Inertia Bases
- O. Vibration Isolation
- P. Electric Heat Tracing

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
- 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. Submit in accordance with provisions of Section 230010.
- 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.

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

2.2 PRESSURE GAUGES

- A. Manufacturer: Moeller
- B. Other acceptable manufacturers offering equivalent products:
 - 1. American
 - 2. Trerice
 - 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

2.3 PRESSURE GAGE TAPPINGS

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

2.4 STEM TYPE THERMOMETERS

- A. Manufacturer: Weksler AADHFC
- B. Other acceptable manufacturers offering equivalent products:
 - 1. American
 - 2. Terice
 - 3. Moeller
 - 4. Substitutions: Permitted in accordance with Division 1.
- C. Thermometer: ASTM E1, adjustable angle, solar digital.
 - 1. Stem: 3/4" NPT brass, 3-1/2"
 - 2. Accuracy: ASTM E77 2%

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 accepted substitute
- B. Hydronic 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 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.

2.10 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 EQUIPMENT CURBS

- A. Fabrication: Welded 18-ga galvanized steel shell and base, mitered 3" cant, 1-1/2" thick insulation, factory installed wood nailer. Curbs shall be installed flat and level. Mechanical Contractor shall provide blocking as required.

2.12 SLEEVES AND SEALANTS

- 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 Rectangular Ductwork: Galvanized steel.
- D. Firestopping Insulation: Glass fiber type, non-combustible.
- E. Sealant: Acrylic.
- F. Firestopping for non-plastic piping, ductwork shall be 3M, Dow, Corning fire caulk/packing or accepted substitute. Install steel angles around duct penetrations.
- G. Firestopping for polypropylene pipe penetrations shall be 3M Fire Barrier FS-195 Wrap/Strips with restraint collar or accepted substitute installed per manufacturers detail (UL System 64).

2.13 MOTORS

- A. Manufacturers:
 - 1. Century
 - 2. Westinghouse
 - 3. Lincoln
 - 4. Baldor
 - 5. Or accepted substitute
- 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. All motors shall be high efficiency 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.

2.14 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 Owner's room numbering system.
- C. Ceiling grid tags shall be provided to indicate access point for service location for VAV boxes and other equipment above ceilings.

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. 1-1/2" 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 09900, 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 INERTIA BASES

- A. Structural Bases:
 - 1. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
 - 2. Construction: Welded structural steel with gusseted brackets, supporting equipment and motor with motor slide rails.

- B. Concrete Inertia Bases:
 - 1. Mass: Minimum of 1.5 times weight of isolated equipment.
 - 2. Construction: Structured steel channel perimeter frame, with gusseted brackets and anchor bolts, adequately reinforced, concrete filled.
 - 3. Connecting Point: Reinforced to connect isolators and snubbers to base.
 - 4. Concrete: Reinforced 3,000 psi concrete.

2.18 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.

2.19 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.

2.20 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.

2.21 ROOF CURBS

- A. Curbs shall be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
- B. Curb shall be provided with a vibration isolation rail assembly.
- C. Curb shall be provided with acoustical panels.

1. General: Acoustical Panel shall be factory laminated construction as manufactured by Kinetics Noise Control or equal.
2. Materials: Panel layers shall be comprised of 2" 3PCF AcoustiBoard fiberglass and 5/8" AcoustiSheet as manufactured by Kinetics Noise Control or equal.
3. Acoustical Panels: All panels and their components shall be pre-fabricated, sectional, and modular; designed for easy and accurate field assembly.
4. Panel Construction: All panels shall be 7-1/4" inches thick (min), comprised of alternating layers of 2" fiberglass absorption panels and 5/8" acoustically dampened sheetrock.

2.22 FIRESTOPPING

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 wrap-around 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.
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 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.

2.23 STARTERS

A. All starters shall be Hand/Off/Auto Type.

B. Starters for rooftop equipment (HRU'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. 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. Gages 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 gage. 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 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.
5. Coil and conceal excess capillary on remote element instruments.
6. Provide instruments with scale ranges selected according to service with largest appropriate scale.
7. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45° off vertical.
8. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
9. Locate test plugs adjacent thermometers and thermometer sockets, pressure gauges and pressure gage 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 Section 09900.
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. 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.
7. Identify control panels and major control components outside panels with plastic nameplates.
8. Identify thermostats relating to terminal boxes or valves with nameplates.
9. Identify valves in main and branch piping with tags.
10. Identify air terminal units and radiator valves with numbered tags.

11. Tag automatic controls, instruments, and relays. Key to control schematic.
12. 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.
13. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
14. Provide Valve Identification Chart. Post framed chart in Boiler Room.
15. Install underground plastic pipe markers 6" to 8" below finished grade, directly above buried pipe.
16. 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.

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 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 Mechanical 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: Pumps – inertia bases, 2" (minimum) deflection springs; Heat Pumps and Air Handlers in Mechanical Rooms on grade – 1/4" deflection neoprene or fiberglass pads; Ceiling mounted air handling units or heat pumps - 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 or heat pumps, any piping larger than 1" diameter should have the first three hangers of the same deflection as the equipment (1").
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.

- E. 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.
- F. 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.
- G. 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.
 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-gauge galvanized steel and shall be 8" long.
- H. Equipment Bases and Supports:
1. Provide housekeeping pads of concrete, minimum 4" thick and extending 4" beyond supported equipment.
 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.
 5. Shall be by the contractor installing the related equipment.
- I. Flashing:
1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

2. 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.

J. 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 one inch 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. Pressure Gauge Schedule:

1. Location: Pumps
Pressure Tanks
Boiler Inlet/Outlet
Cooling Tower Inlet/Outlet

B. Stem Type Thermometer Schedule:

1. Location: Boiler Inlet/Outlet
Pump Outlet
Mixing Valve Inlets/Outlets
Cooling Tower Inlet/Outlet

C. Supports and Hangers:

PIPE SIZE INCHES	MAX. HANGER	SPACING (FT)	HANGER ROD DIAMETER
	HORIZONTAL	VERTICAL	INCHES
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	10	3/8
C.I. Bell and Spigot (or No Hub) and at joints	5	15	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 230100

SECTION 230250 – HVAC INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

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

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 230010.
- 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 PRODUCTS

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

2.2 DUCT INSULATION

- A. Provide and install acoustic and thermal lining on the first 10-ft of duct in all supply air, and return air ductwork as specified. Exhaust only ductwork does not need insulated unless specifically noted.
- B. Supply and return air 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 6.0 or greater.
- C. Supply and return air ductwork downstream of lined ductwork and fresh air ductwork shall be wrapped in insulation with a thermal conductivity of approximately 0.16 BTU/Hr – sq ft - °F – inch and a minimum R-value of 6.0 or greater.
- D. All insulation shall meet the code required flame and smoke ratings and shall be suitable for plenums.
- E. All ductwork installed outside the building insulation envelope (uninsulated attic) shall be lined as specified above and wrapped with additional 2", 1.5 PCF density with an installed R-value of 6.4, for greater for a total R-Value of 12.0 or greater. All ductwork on roof shall be lined as specified and externally insulated with 2" Polyisocyanite insulation for greater for a total R-Value of 12.0 or greater. Insulation shall be glued and mechanically fastened to ductwork and sealed at joints with vapor barrier tape. Ductwork installed on the building exterior shall be covered with Alumaguard® All Weather Cool Wrap composite membrane (37 mils), or equal.
- F. Spiral ductwork upstream of VAV boxes shall be wrapped with fiberglass duct wrap, not lined, with a thermal conductivity of approximately 0.16 BTU/Hr – sq ft - °F – inch and a minimum R-value of 6.0 or greater.
- G. All trunk ductwork downstream of fan coil units (FCU), fan-powered VAV (FV) boxes, and non-fan-powered VAV (V) Boxes shall be lined in accordance with paragraph B. Round branch ductwork shall be wrapped in insulation with a thermal conductivity of approximately 0.16 BTU/Hr – sq ft - °F – inch and a minimum R-value of 6.0 or greater. Round ductwork directly connected to a VAV Box shall be wrapped as described above.

- H. Transfer air ductwork shall be lined with 1" acoustic insulation.
- I. Kitchen hood exhaust shall be wrapped with 3M Fire Master Fast Wrap and 3M Fire Barrier 2000+ silicon treatment and installed in accordance with the manufacturer's installation instructions and details on the contract documents.

2.3 HVAC PIPING INSULATION

- A. All HVAC (hot water and chilled water, including make-up water) water supply and return pipes, equipment, fittings, suction diffusers, hot/cold surfaces, flanges, and valves shall be insulated with heavy density molded fiberglass insulation similar to Owens/Corning SSL II with ASJ MAX FIBERGLAS pipe insulation or accepted substitute with all service jacket, self-sealing lap and U.L. listed.
- B. All exposed HVAC piping Insulation shall be covered in a PVC jacket with sealed joints.
- C. 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.
- D. Condensate drain piping systems shall be insulated with Flexible Elastomeric Insulation.
 - 1. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Grade 1, Type I for tubular materials. UL Classified to UL 723 at 25/50. Basis-of-Design Product: Subject to compliance with requirements, provide Armacell LLC; ArmaFlex Ultra or ArmaFlex Ultra SA or a comparable product by one of the following: Aeroflex USA, Inc., or K-Flex USA.

2.4 REFRIGERANT PIPING INSULATION

- A. All refrigeration lines shall be insulated with nominal 3/4" wall thickness flexible elastomeric closed cell pipe insulation, 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.
- C. All exposed piping Insulation shall be covered in a PVC jacket with sealed joints.
- D. All exterior refrigeration piping shall be insulated with 1" FoamGlass Insulation by Pittsburgh-Corning with UV Resistant protective covering similar to Pittwrap IW50 AL Jacketing. Install in accordance with manufacturer's specifications and recommendations.

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. Tape and mastic all joints.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
 - 3. PVC fitting covers shall be used. Contractor shall double insulation inserts.
 - 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.
 - 6. Tape all joints and seal with mastic to maintain vapor barrier.
- 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. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
- G. 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.
- H. For exterior applications, provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
- I. All ductwork on roof shall be lined as specified and externally insulated with 2" Polyisocyanite insulation. Insulation shall be glued and mechanically fastened to ductwork and sealed at joints with vapor barrier tape. Insulation shall be weatherproofed and covered with Aluma Guard 60 (White) membrane or equal.
- J. External Duct Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Secure insulation without vapor barrier with staples, tape, or wires.
 - 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
 - 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- K. 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. Duct covering shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411.
 - L. 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 as required by NFPA 90A.
 - M. HVAC Piping shall be insulated with thickness of insulation indicated below
 1. Chilled Water Supply/Return:
 - Pipe Size – Up to 1-1/2" – 1-1/2" Thick Insulation
 - Pipe Size – 1-1/2" and Up – 2" Thick Insulation
 Hot Water Supply/Return:
 - Pipe Size – Up to 1-1/2" – 1-1/2" Thick Insulation
 - Pipe Size – 1-1/2" and Up – 2" Thick Insulation
 Transition insulation at hangers as required

Plumbing piping shall be insulated with thickness of insulation indicated below:

 - CW Pipe – 0.5" thick
 - Condensate Pipe – 0.5" thick
 2. Provide additional thickness as required to prevent surface condensation on chilled water pipe system.
 - N. 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 2500 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 accepted substitute. Mechanical fasteners shall be Gripnail Corporation, or accepted substitute with self-locking washers, and shall be spaced not more than 6" 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 accepted substitute.
 5. Duct liner shall be anti-microbial and impervious to dust and dirt.
 6. All exposed ductwork shall be lined. Ductwrap on exposed ductwork shall not be permitted.

END OF SECTION 230250

SECTION 230510 - HVAC PIPING & SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings for:
 - 1. Heating Water Piping System
 - 2. Chilled Water System
 - 3. Refrigerant Piping
- B. Valves
- C. Expansion Tank
- D. Air Vents

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

- 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 butterfly valves only in chilled and condenser water systems.
- I. 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 230010.
- 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 HVAC SYSTEM 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.
 - 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:
 - 1) 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 PIPE HANGERS AND SUPPORTS

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

2.3 BALL VALVES

- A. Up to and Including 3 Inches:
 - 1. Manufacturers:
 - a. Nibco
 - b. Crane
 - c. Stockham
 - d. Victaulic
 - e. Anvil – Gruvlok Company
 - 2. Bronze 2-piece body, bronze ball, Teflon seats and stuffing box ring, extended lever handle (length to exceed insulation thickness) with balancing stops, solder, or threaded ends.
 - 3. For chilled water valves up to 2-1/2", 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.

2.4 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.

2.5 SWING CHECK VALVES

- A. Manufacturers:
 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.

2.6 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.

2.7 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.

2.8 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.

2.9 DIAPHRAGM-TYPE EXPANSION TANKS

- A. Manufacturers:
1. Amtrol
 2. Taco

3. John Wood

- B. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
- D. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
- E. Accessories: Pressure gauge and air-charging fitting, tank drain, pre-charge to 12 psig.

2.10 IN-LINE AIR SEPARATORS (FOR HOT WATER/CHILLED WATER LOOP)

- A. In-Line Air Separators:
 - 1. Manufacturers:
 - a. Bell & Gossett
 - b. Armstrong
 - c. Amtrol
 - d. TACO
 - 2. Cast iron for sizes 1-1/2" and smaller, or steel for sizes 2" and larger; tested and stamped in accordance with ASME SEC 8-D; for 125 psig operating pressure.

2.11 PUMP SUCTION DIFFUSERS

- A. Manufacturers:
 - 1. Bell & Gossett
 - 2. Taco
 - 3. Armstrong
 - 4. Amtrol
 - 5. Victaulic
 - 6. Anvil – Gruvlok Company
- B. Fitting: Angle patten, cast iron body, flanged, rated for 175 psig working pressure, with inlet vanes, cylinder, strainer with 3/16" diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.
- C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping inside.

2.12 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.

2.13 BACKFLOW PREVENTER

- A. Backflow preventer shall be Watts Regulator Series 909 or equal with strainer.

2.14 FLOW CONTROLS

- A. Manufacturers:
 - 1. Bell & Gossett: Circuit Setter Plus
 - 2. Taco Comfort Solutions
 - 3. Armstrong Fluid Technologies
 - 4. Victaulic
- 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.

2.15 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/phyosphorous copper alloy with melting range 1190 to 1480°F
- B. Valves and associated specialties shall be suitable for refrigerant service.

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, condenser 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 230100.
- 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 1/2" space between finished covering and adjacent work.
 - 4. Place hangers within 12" of each horizontal elbow.
 - 5. Use hangers with 1-1/2" 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.
 - 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. Use eccentric reducers to maintain top of pipe level.
- 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 bell and spigot pipe with bell end upstream.

- R. Install unions downstream of valves and at equipment or apparatus connections.
- S. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- T. Install ball valves for throttling, bypass, or manual flow control services.
- U. Provide flow controls in water recirculating systems where indicated. Size valves to meet flow quantities indicated. All automatic flow control valves shall be installed with a strainer upstream of valve as well as isolation valves to facilitate cartridge replacement.
- V. Provide traps at condensate pipe connection to all units.
- W. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846 Appendix.
- X. Underground Pipe Installation:
 - 1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
 - 2. Remove standing water in the bottom of trench.
 - 3. Do not backfill piping trench until field quality-control testing has been completed and results approved.
 - 4. Install piping at uniform grade of 0.2%. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points and elsewhere as required for system drainage. Install manual air vents at high points.
 - 5. Install components with pressure rating equal to or greater than system operating pressure.
 - 6. Install piping free of sags and bends.
 - 7. Install fittings for changes in direction and branch connections.
 - 8. Provide sleeves and mechanical sleeve seals through exterior building walls.
 - 9. Secure anchors with concrete thrust blocks.
 - 10. Identification: Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping.
- Y. Refrigerant Piping:
 - 1. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 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. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
8. Fully charge completed system with refrigerant after testing.
9. Test refrigeration system in accordance with ASTM B31.5

END OF SECTION 230510

SECTION 230540 - HVAC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Base Mounted 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 230010.
- 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 MANUFACTURERS

- A. Subject to compliance with these specifications, the following manufacturers shall be acceptable:
 - 1. Bell & Gossett
 - 2. Taco Comfort Solutions
 - 3. Armstrong Fluid Technology
- B. The above manufacturers are approved for this project. This approval does not relieve the manufacturer from strict compliance with this specification regardless of the manufacturer's own standards. Other manufacturers and or models seeking prior approval must send a detailed Engineering proposal with drawings to the Engineer ten days prior to the bid. Prior approval will be written; no verbal approvals will be given

2.2 INLINE PUMPS

- A. The pumps shall be 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.
- B. 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.
- C. 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.
- D. 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.
- E. 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.
- F. A flexible type coupling to dampen starting torque and torsional vibration shall be employed between the pump and motor.
- G. Pump shall be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
- H. 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.

- I. 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.
- J. 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.
- K. Each pump shall be factory tested and name-plated before shipment.
- L. 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. All VFD's shall include a bypass.

2.3 BASE MOUNTED PUMPS

- A. The pump shall be single stage, end suction design, in cast iron and bronze fitted construction. The pump internals shall be capable of being serviced without disturbing piping connections or motor.
- B. The impeller shall be of the enclosed type, dynamically balanced and keyed to the shaft and secured with a suitable locknut.
- C. Pump shall be standard single mechanical seal with carbon seal ring and ceramic seat. Provide with wear ring.
- D. A replaceable shaft sleeve shall be furnished to cover the wetted area of the shaft under the seal or packing.
- E. The bearing frame assembly of the pump shall be fitted with re-greasable ball bearing equivalent to electric motor bearing standards for quiet operation.
- F. The pump and motor shall be mounted on a common baseplate of heavy structural steel design with securely welded cross members and open grouting area. A flexible coupler, capable of absorbing torsional vibration shall be employed between the pump and motor, and it shall be equipped with a suitable coupling guard as required.
- G. The pump shall be factory tested, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. A set of installation instructions shall be included with the pump at the time of shipment.
- H. Pump motors shall be premium high-efficiency.
- I. 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.

2.4 VARIABLE FREQUENCY PUMP DRIVE (VFD)

- A. Adjustable Frequency Drive (AFD) shall be a sine coded pulse width modulated (PWM) design that operates directly from 3-phase 480 VAC \pm 10% 60 Hz utility power. AFD shall generate a sine-coded, adjustable voltage/frequency 3-phase output for complete speed control of any conventional squirrel cage induction motor. 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. AFD shall maintain a power factor of not less than .95 throughout its speed range. AFD shall communicate to the control system in accordance with the ATC Installer's requirements. Pump system manufacturer is required to determine scope of this work and coordinate.
- B. Adjustable frequency drive shall be ABB or Yaskawa.
- C. Basic Design: Adjustable frequency drive shall have the following basic design:
 - 1. Converter: Consists 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: Uses 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: Consists of 2 printed circuit boards and incorporate a dual microcomputer central processing unit to control all inverter, converter, and external interface functions.
 - 4. Enclosure: NEMA 12 with external heat sink configuration to minimize panel heat loading.
 - 5. Design Features: Adjustable frequency drive shall have as a minimum the following design features:
 - 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. Adjustable acceleration and deceleration
 - h. Run and fault LED's
 - i. Run and fault contacts for customer use
 - 6. Protective Features: 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 condition.
 - 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
 - 11) DC bus discharge indicator
 - 12) Current limiting DC bus fuse
 - 13) Isolated operators' controls
 - 14) Phase to phase short circuit protection
 - 15) Heat sink over temperature protection
 - 16) Motor KW
 - 17) Motor current
 - 18) DC bus voltage
7. Adjustments: Adjustable frequency drive shall have the following adjustments available:
 - a. Acceleration: 0.2 to 1800 seconds linear
 - b. Deceleration: 0.2 to 1800 seconds linear
 - c. Volts/Hertz: 15 patterns
 8. Entire system shall be compatible with the ATC System.
 9. EMI/RFI filters. All VFD's shall include 3 EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100' of motor cable. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.
 10. All VFD's shall include a minimum of 5% impedance reactors.
 11. Harmonic distortion shall be held to 8% current distortion (THD) at the output of the source transformer. This is the point of common coupling defined in IEEE 519-1992.
 12. The preferred method of reducing harmonic distortion shall be through the use of an active filter applied at the point of common coupling. This is a parallel system that does not result in a point of failure for the associated VFD's and provides correction for harmonics caused by other non-linear loads such as computers, LED lighting, and lighting ballast systems. Acceptable manufacturers will be Trans Coil, Mirus, and MTE.
 13. 5th harmonic trap filters will be accepted but must be mounted integrally in the VFD.
 14. Short Circuit Withstand Rating of the chiller electrical enclosure shall be 380, 400, and 460V: 100,000 amps. Rating shall be published in accordance with UL508 or EN60204-1.
- D. Additional Features:
1. Control center shall be UL listed including the variable frequency drive compartments. Control center shall also include an incoming line section with a main disconnect switch with door interlocking mechanism. Control center shall include a bottom (top) cable chase.
 2. 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. Analog signals shall be 4-20 mA DC and digital signals shall be dry for C contacts. Analog signals shall be able to be monitored from the building automation system.
 3. VFD shall include capability for full manual bypass.
- E. Provide fused disconnect with VFD.

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. Install base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place.
- G. Lubricate pumps before start-up.

END OF SECTION 230540

SECTION 230545 - CHEMICAL WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleaning of Piping Systems
- B. Chemical Treatment

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 230010.
- 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 R Faucets shall be Delta Model 28C4443, cast brass wall mount two handle sink faucet with 11" swing spout, 8" centers, lever blade handles, and 1.5 gpm aerator equiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.5 MAINTENANCE SERVICE

- A. Furnish service and maintenance of treatment systems for one year from Date of Substantial Completion.
- B. Furnish monthly technical service visits on the Evaporative condenser, for one year starting at Date of Substantial Completion, 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. Provide quarterly reports for the closed loop system.
- C. Furnish laboratory and technical assistance services during this maintenance period.

- D. Furnish onsite inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program and make recommendations in writing based upon these inspections.

PART 2 - PRODUCTS

2.1 SYSTEM PREPARATION

- A. Clean and flush piping system, remove, clean, and replace strainer screens once the system water is clear.
- B. Water flush applies to the following systems: Loop Water
- C. Refill the system with water and allow for 5 volume percent of precleaner for the removal of scale, oils, and other extraneous materials. Add the required amount of cleaner and circulate for 6 to 8 hours at 150°F, or 12 hours if less than 90°F.
- D. The system cleaner shall be approved as a cleaner in a system utilizing water.
- E. Drain the system after the required circulation period as quickly as possible, this will prevent settling of foulants. Run circulating pumps and flush with clean water until the discharge water is clear.
- F. When system water is clear, remove, clean, and replace all strainers.
- G. Fill the system with water, all air vents should be opened during the filling process to ensure that the air is purged from the system. Once the system is full, all air vents should be closed.
- H. Circulate water for 24 hours before a sample is taken and tested for the proper concentration, freeze point, reserve alkalinity and pH.

2.2 CLOSED SYSTEM TREATMENT

- A. Chemical Cleaner:
 - 1. FORMULA 6960 Alkaline Cleaner New Equipment Cleaner or equal.
- B. Product Description: Liquid non-alkaline compound with emulsifying agents and detergents to remove grease and petroleum products
- C. Freeze Protection and Scale and Corrosion Inhibitor:
 - 1. FORMULA 6295 Corrosion Inhibitor or equal
- D. Sequestering agent to reduce deposits and neutralize pH.
- E. Corrosion inhibitors; liquid boron-nitrite, molybdate, silicate, sodium tolytriazole, low molecular weight polymers, and phosphonates.

2.3 EQUIPMENT FOR THE CLOSED LOOP SYSTEM

- A. Manufacturers: Vector Industries Model FA-700AL VF-700HT shall be used on the Closed Loop System.
- B. Provide 30 filters for Closed Loop System Qty. 5 (10 micron), Qty 10 (5 micron), and Qty 15 (1 micron) per system.
- C. Provide a three-station corrosion coupon rack, Model ACR-35A. Provide six-month analysis of Stainless Steel, Copper, and Mild Steel coupon analysis.
- D. Provide a water meter with BAS communications. The BAS communications shall be installed by the Controls Contractor.

2.4 TEST EQUIPMENT

- A. Test kits to monitor the water treatment chemistry of the closed loop systems.
- B. Furnish following test kit
 1. Tintometer Molybdenum inhibitor test kit.
 2. Conductivity meter, range 0 - 10,000 micro-ohms.
 3. Wide range pH test kit to monitor pH of tower water.
 4. One case of 12 bacterial test dipslides.
 5. High nitrite test kit.
 6. Refractometer

2.5 HVAC WATER TREATMENT VENDOR

- A. Basis of Design:
Water Treatment By Design
Principal: Mark Coldren
(717) 938-0670

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 PREOPERATIONAL SYSTEM CLEANOUT

- A. All loop water, pipes and related equipment shall be thoroughly flushed out with precleaning chemicals designed to remove deposition such as pipe dope, oils, loose rust, mill scale and other extraneous materials. Recommended dosages of 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.

3.3 PREPARATION FOR CLOSED LOOP SYSTEM

- A. Add Formula 6960 new equipment cleaner and allow to circulate for one to three days. During the circulation process it is very important that all zones are open to the cleaning solution. Flush system until water runs clear and the incoming pH is within 0.5 pH units of the closed loop water.
- B. We shall then add our Formula 6295 to achieve a residual of 300-400ppm expressed as Molybdate.

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
 - 8. All services shall be provided by a qualified, full time representative of the Water Treatment Company
- B. All services shall be provided by a qualified, full-time representative of the Water Treatment Company.

3.5 PIPING AND WIRING

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

END OF SECTION 230545

SECTION 230800 - HVAC SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Related Sections:
 - 1. Section 019100 - Commissioning Requirements

1.2 DESCRIPTION

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

HVAC Systems

VAV Boxes (V)
Fan Powered VAV Boxes (FPV)
Indoor Air Handling Units (AHU)
Dedicated Outside Air Systems (DOAS)
Energy Recovery Ventilators (ERV)
Kitchen Hood Exhaust Fan and Make-up Air System
Indirect Gas-Fired Make-up Air Units
Ductless Air Conditioners
Exhaust Fans
Cabinet Heaters
Unit Heaters
Wall Heaters
Boilers
Hot and Chilled Water System Pumps
ATC Control System

1.3 DEFINITIONS

- A. Calibrate: For the purpose of Commissioning this shall be defined as the following: Contractor shall check accuracy of sensors, motor operators, and other items by a means acceptable to the Commissioning Agent.

1.4 SCOPE OF WORK

- A. The HVAC Contractor, Controls and TAB Contractor shall perform as described in the execution section of this specification functional testing, calibrating field installed devices and verifying sequence of operation for all of equipment and devices except for the following percentages for the following equipment and devices that are a part of that equipment and systems:
 - 1. VAV Boxes and Fan Powered VAV Boxes: 20%
 - 2. Water Source Heat Pumps: 10%
 - 3. Ductless Air Conditioners: 20%
 - 4. Exhaust Fans: 10%

5. Electric Cabinet, Unit, and Wall Heaters: 10%
6. ATC Control System: Calibrate 15% in total of all field installed sensors across all installed systems.

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 $\pm 0.1^\circ\text{F}$. Pressure sensors shall have an accuracy of $\pm 2.0\%$ 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.
 - 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.
 - 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 230900 "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 (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.
 - 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 230800

SECTION 230835 - HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cabinet Heaters
- B. Unit Heaters
- C. Single Duct VAV Boxes
- D. Fan Powered VAV Boxes
- E. Ductless Air-conditioning Units
- F. Electric Heaters

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with provisions of Section 230010.

1.4 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 70 code for internal wiring of factory wired equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. CABINET UNIT HEATERS, CONVECTORS, UNIT HEATERS
 - 1. Airtherm
 - ~~2.~~ Sigma
 - 3. Sterling
 - 4. Modine
 - 5. Rittling

2.2 CABINET HEATERS (CUH)

- A. Cabinet unit heaters Modine Model CW.

- B. Furnish and install where indicated on the drawings, horizontal recessed style cabinet heaters of the capacity indicated on the schedule. Units shall include galvanized steel chassis, water coil, fanboard, fanwheel, housing, motor, filter and insulation.
- C. Horizontal Recessed Models – Unit shall have 18-gauge steel, removable, 4 side overlap bottom panel adjustable 3/8" with full length, piano-type hinge at back and camlocks at front.
- D. All cabinet parts shall be cleaned, bonderized, phosphatized and coated with baked-on primer ready for field painting. Unit painting by Architect. Access doors and front panel shall be tamper-proof.
- E. Hot water heating coils shall be 5/8" OD copper finned tube construction factory tested to 300 PSIG. Units shall be provided with shut-off valves on both supply and return connections. All control valves, valving and piping shall be concealed inside unit.
- F. Provide on-off switch to disconnect power to unit for servicing.

2.3 UNIT HEATERS (UH)

- A. Horizontal heater unit Modine Model HC.
- B. Casing shall be 2-piece with "picture frame" front formed into wrap-around sides, top and bottom. Horizontal louvers with louver keepers shall be standard. Unit shall have 18-ga back panel with deep-draw fan orifice for extreme rigidity and cast brass coil supply and return pipe tap connectors bolted to back corners. Casings shall be phosphatized to prevent corrosion and painted with green baked enamel.
- C. Fan shall be high efficiency fan with aluminum blades, factory balanced and sturdy for standard or spark-proof applications.
- D. Hot water headerless coils are single tube, single serpentine. Fins are aluminum Sigma-Flo, mechanically bonded to seamless copper tubing. All coils shall be 1-row deep in airflow direction and shall be tested at 300 psig air under water. Standard coils shall have .031 copper tubing suitable for use on hot water up to 200 psi or 325°F.
- E. Totally enclosed, 115/60/1 Class "B" insulated, shaded pole and PSC motor shall be standard. Motor shall be sleeve bearing. Motors shall have built-in overload protection. Motors shall be able to be oiled.
- F. Unit shall be controlled as described in the ATC Section.

2.4 NON-FAN-POWERED VAV BOX (V-)

- A. Acceptable Manufacturers: These Specifications set forth the minimum requirements for single duct VAV terminal units. If they comply with these specifications, single duct VAV terminal units manufactured by one of the following manufacturers will be acceptable:
 - 1. JCI

2. Trane
3. Nailor Industries
4. Price

B. Construction:

1. Terminals shall be constructed of not less than 22-ga galvanized steel with a minimum G90 zinc coating, able to withstand a 125-hour salt spray test per ASTM B-117. Stainless steel casings, or galvanized steel casings may be used as an alternative. The terminal casing shall be mechanically assembled (spot-welded casings are not acceptable).
2. Casing shall be internally lined with 1/2" thick, 4 pound per cubic foot skin, dual density fiberglass insulation, rated for a maximum air velocity of 3600 f.p.m. In addition to using adhesive complying with NFPA 90A, the insulation shall incorporate a secondary mechanical fastener attached to the unit casing wall (clench nail). Adhesive as the only method of fastening the insulation to the casing is not acceptable. Maximum thermal conductivity shall be 0.24. Insulation must meet all requirements of ASTM Standards C1071, (fibrous glass duct lining insulation) G21, (Resistance of synthetic polymers to fungi) UL 181, (materials for the fabrication of air duct and air connector systems) and NFPA 90A, (Installation of air conditioning and ventilating systems). Raw insulation edges on the discharge of the unit must be covered with metal liner to eliminate flaking of insulation during field duct connections. Simple "buttering" of raw edges with an approved sealant is not acceptable
3. All appurtenances including control enclosures and electric heating coils shall not extend beyond the top and bottom of the unit casing. At an inlet velocity of 2000 f.p.m., the static pressure drop across the basic terminal or basic terminal with a sound attenuator shall not exceed .08" W.G. for all unit sizes.

- C. Primary Air Valve: The primary air valve shall consist of a minimum 22-ga cylindrical body that includes embossment rings for rigidity. The damper blade shall be connected to a solid shaft by means of an integral molded sleeve which does not require screw or bolt fasteners. The shaft shall be manufactured of a low thermal conducting composite material and include a molded damper position indicator visible from the exterior of the unit. The damper shall pivot in nylon bearings. The damper actuator shall be mounted on the exterior of the terminal for ease of service. The valve assembly shall include internal mechanical stops for both full open and closed positions. The damper blade seal shall be secured without use of adhesives. The air valve leakage shall not exceed 1% of maximum inlet rated airflow at 3" W.G. inlet pressure.

- D. Primary Airflow Sensor: Differential pressure airflow sensor shall traverse the duct using the equal cross-sectional area or log-linear traverse method along two perpendicular diameters. Single axis sensor shall not be acceptable for duct diameters 6" or larger. A minimum of 12 total pressure sensing points shall be utilized. The total pressure inputs shall be averaged using a pressure chamber located at the center of the sensor. A sensor that delivers the differential pressure signal from one end of the sensor is not acceptable. The sensor shall output an amplified differential pressure signal that is at least 2.5 times the equivalent velocity pressure signal obtained from a conventional pitot tube. The sensor shall develop a differential pressure of 0.03" w.g. at an air velocity of < 450 FPM. Documentation shall be submitted which substantiates this requirement. Brass balancing taps and airflow calibration charts shall be provided for field airflow measurements.

E. Electric Heaters:

1. Terminal shall include an integral electric heater where indicated on the plans. Heater shall be manufactured by the terminal unit manufacturer and shall be ETL listed. The heater cabinet shall be constructed of not less than 20-ga galvanized steel with a minimum G90 zinc coating. Stainless steel cabinets, or galvanized steel casings may be used as an alternative. Heater shall have a hinged access panel for entry to the controls.
2. Electric heaters shall be factory mounted to the terminal with the heating elements located upstream of the airflow control damper to ensure uniform velocity profile over elements. Elements located downstream of the damper are not acceptable.
3. A power disconnect shall be furnished to render the heater non-operational. Heater shall be furnished with all controls necessary for safe operation and full compliance with UL 1995 and National Electric Code requirements.
4. Heater shall have a single point electrical connection. It shall include a primary disc-type automatic reset high temperature limit, secondary high limit(s), airflow switch, Ni-Chrome elements, and fusing per UL and NEC. Heater shall have complete wiring diagram with label indicating power requirement and KW output.
5. Proportional electric heat shall utilize SSR control. (Solid State Relay) The SSR shall feature zero voltage switching, to avoid voltage transients which would be generated if the power is switched on or off at the peak of the AC voltage. The proportional electric heat shall be factory mounted and wired and ETL listed as an assembly.

F. Foil Faced Insulation: Insulation shall be covered with scrim backed foil facing. All insulation edges shall be covered with foil or metal nosing. Insulation shall meet ASTM C1136 as a low permeance vapor retarding material and ASTM C665 for thermal and acoustic properties of insulation.

2.5 FAN POWERED VAV BOX (FV-)

A. Acceptable Manufacturers: These Specifications set forth the minimum requirements for single duct VAV terminal units. If they comply with these specifications, single duct VAV terminal units manufactured by one of the following manufacturers will be acceptable:

1. JCI
2. Trane
3. Nailor Industries
4. Price

B. General:

1. Furnish and install Series Flow Constant Volume Fan Powered Terminals of the sizes and capacities scheduled. Units shall be ETL listed. Terminals with electric heat shall be listed as an assembly. Separate listings for the terminal and electric heater are not acceptable. Terminals shall include a single point electrical connection. Terminal units shall be AHRI certified and bear the AHRI 880 seal.
2. The entire unit shall be designed and built as a single unit. Field-assembled components or built-up terminals employing components from multiple manufacturers are not acceptable.

C. Construction:

1. Terminals shall be constructed of not less than 22-ga galvanized steel with a minimum G90 zinc coating, able to with-stand a 125-hour salt spray test per ASTM B-117. Stainless steel

- casings, or galvanized steel casings may be used as an alternative. The terminal casing shall be mechanically assembled (spot-welded casings are not acceptable).
2. Casing shall be internally lined with 1/2" thick, 4 pound per cubic foot skin, dual density fiberglass insulation, rated for a maximum air velocity of 3600 f.p.m. In addition to using adhesive complying with NFPA 90A, the insulation shall incorporate a secondary mechanical fastener attached to the unit casing wall (clench nail). Adhesive as the only method of fastening the insulation to the casing is not acceptable. Maximum thermal conductivity shall be 0.24. Insulation must meet all requirements of ASTM Standards C1071, (fibrous glass duct lining insulation), G21, (Resistance of synthetic polymers to fungi), UL 181, (materials for the fabrication of air duct and air connector systems) and NFPA 90A, (Installation of air conditioning and ventilating systems). Raw insulation edges on the discharge of the unit must be covered with metal liner to eliminate flaking of insulation during field duct connections. Simple "buttering" of raw edges with an approved sealant is not acceptable.
 3. Casing shall have full bottom access to gain access to the primary air valve and fan assembly. The opening shall be sufficiently large to allow complete removal of the fan if necessary. The casing shall be constructed in a manner to provide a single rectangular discharge collar. Multiple discharge openings are not acceptable. All appurtenances including control enclosures and electric heating coils shall not extend beyond the top or bottom of the unit casing.
- D. Sound: The terminal manufacturer shall provide AHRI certified sound power data for radiated and discharge sound. The sound levels shall not exceed the octave band sound power levels indicated on the schedule. If the sound data does not meet scheduled criteria, the contractor shall be responsible for the provision and installation of any additional equipment or material necessary to achieve the scheduled sound performance.
- E. Primary Air Valve: The primary air valve shall consist of a minimum 22-ga cylindrical body that includes embossment rings for rigidity. The damper blade shall be connected to a solid shaft by means of an integral molded sleeve which does not require screw or bolt fasteners. The shaft shall be manufactured of a low thermal conducting composite material and include a molded damper position indicator visible from the exterior of the unit. The damper shall pivot in nylon bearings. The damper actuator shall be mounted on the exterior of the terminal for ease of service. The valve assembly shall include internal mechanical stops for both full open and closed positions. The damper blade seal shall be secured without use of adhesives. The air valve leakage shall not exceed 1% of maximum inlet rated airflow at 3" W.G. inlet pressure.
- F. Primary Airflow Sensor: Differential pressure airflow sensor shall traverse the duct using the equal cross-sectional area or log-linear traverse method along two perpendicular diameters. Single axis sensor shall not be acceptable for duct diameters 6" or larger. A minimum of 12 total pressure sensing points shall be utilized. The total pressure inputs shall be averaged using a pressure chamber located at the center of the sensor. A sensor that delivers the differential pressure signal from one end of the sensor is not acceptable. The sensor shall output an amplified differential pressure signal that is at least 2.5 times the equivalent velocity pressure signal obtained from a conventional pitot tube. The sensor shall develop a differential pressure of 0.03" w.g. at an air velocity of < 450 FPM. Documentation shall be submitted which substantiates this requirement. Brass balancing taps and airflow calibration charts shall be provided for field airflow measurements.

G. Fan Assembly:

1. The unit fan shall utilize a forward curved, dynamically balanced, galvanized wheel with a direct drive motor. The motor shall be permanent split capacitor type with three separate horsepower taps. Single speed motors with electronic speed controllers are not acceptable.
2. The fan motor shall be un-pluggable from the electrical leads at the motor case for simplified removal (open frame motors only). The motor shall utilize permanently lubricated sleeve type bearings, include thermal overload protection and be suitable for use with electronic and/or mechanical fan speed controllers. The motor shall be mounted to the fan housing using torsion isolation mounts properly isolated to minimize vibration transfer.
3. The terminal shall utilize an electronic (SCR) fan speed controller for aid in balancing the fan capacity. The speed controller shall have a turn down stop to prevent possibility of harming motor bearings.

H. Electric Heaters:

1. Terminal shall include an integral electric heater where indicated on the plans. Heater shall be manufactured by the terminal unit manufacturer. The heater cabinet shall be constructed of not less than 20-ga galvanized steel with a minimum G90 zinc coating. Stainless steel cabinets, or galvanized steel casings may be used as an alternative. Heater shall have a hinged access panel for entry to the controls.
2. A power disconnect shall be furnished to render the heater non-operational. Heater shall be furnished with all controls necessary for safe operation and full compliance with UL 1995 and National Electric Code requirements.
3. Heater shall have a single point electrical connection. It shall include a primary disc-type automatic reset high temperature limit, secondary high limit(s), Ni-Chrome elements, and fusing per UL and NEC. Heater shall have complete wiring diagram with label indicating power requirement and KW output. Heater shall be interlocked with fan terminal to preclude operation of the heater when the fan is not running.
4. Proportional electric heat shall utilize SSR control. (Solid State Relay) The SSR shall feature zero voltage switching, to avoid voltage transients which would be generated if the power is switched on or off at the peak of the AC voltage. The proportional electric heat shall be factory mounted and wired and ETL listed as an assembly.

- I. Foil Faced Insulation: Insulation shall be covered with scrim backed foil facing. All insulation edges shall be covered with foil or metal nosing. Insulation shall meet ASTM C1136 for low permeance vapor retarders and ASTM C665 for biological growth in mineral-fiber blanket thermal insulation.

- J. ECM Motor: Fan motor shall be ECM electronically commutated motor. The motor shall be brushless DC controlled by an integrated controller / inverter that operates the wound stator and senses rotor position to electrically commutate the stator. Motor shall be permanent magnet type with near-zero rotor losses designed for synchronous rotation. The ECM motor shall maintain minimum 70% efficiency over the entire operating range.

2.6 DUCTLESS SPLIT SYSTEM UNITS (AC/CU)

A. Manufacturer:

1. Mitsubishi (Basis of Design)

2. Acceptable Substitutes:
 - a. LG
 - b. Hitachi
- B. Furnish and install Mini-Split system air conditioning units as noted on the plans, ductless splits, concealed, or ceiling cassette type as noted.
- C. Indoor units shall be ceiling or wall hung (as shown on plans) and shall include thermostat and condensate pump.
- D. Outdoor units shall include all standard equipment and controls. Furnish with 5-year warranty for all components.
- E. Unit shall include low ambient control operation down to 0°F.
- F. Electrical Contractor wires to the indoor unit and the Mechanical Contractor wires from the indoor unit to the outdoor unit.

2.7 ELECTRIC HEATERS

- A. Manufacturer:
 1. Qmark (Basis of Design)
 2. Berko
 3. Equal
- B. ____.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Locate baseboard radiation on outside walls and run cover continuously wall-to-wall unless otherwise indicated. Center elements under windows. Install end caps where units butt against walls.
- C. Install convectors and cabinet heaters as indicated. Coordinate to assure correct recess size for recessed convectors.
- D. Protect units with protective covers during balance of construction.

3.2 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.
- D. Fan motor shall be totally enclosed and permanently lubricated for long life and low maintenance.
- E. Heater shall contain automatic reset thermal overload protector to disconnect power in event of overheating due to accidental blockage.
- F. Heater shall contain built-in fan delay switch to energize fan motor only after elements are heated to prevent discharge of unheated air. When heat shuts off, switch shall de-energize fan motor only after residual heat has been dissipated.
- G. Heater shall contain built-in double-pole disconnect switch for added safety during maintenance.
- H. Electric wall heater shall be wall or recessed model as indicated.
- I. Unit shall be furnished with self-contained tamper-resistant thermostat with tamper-proof front cover.

END OF SECTION 230835

SECTION 230855 - AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Air Handling Units
- B. Rooftop Air Handling Units

1.2 REFERENCES

- A. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils
- B. ARI 430 - Central-Station Air-Handling Units
- C. ARI 435 - Application of Central-Station Air-Handling Units
- D. NFPA 70 - National Electrical Code
- E. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 230010.
- B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Unit shall be shipped with doors bolted shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
- B. Installation, Operation, and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location should be followed.
- C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the installation, Operation, and Maintenance Manual.

1.5 SIZING REQUIREMENTS

- A. Manufacturers listed as accepted substitutes are required to verify if their units will fit in the available space with adequate clearances. Unit dimensions shall be equal to, or less than the basis of design units.

PART 2 - PRODUCTS

2.1 AIR HANDLING UNIT

- A. Manufacturers:
 - 1. JCI/York
 - 2. Addison
 - 3. Greenheck Fan Corporation
 - 4. Aeon
- B. Configuration:
 - 1. Filter section
 - 2. Cooling reheating coil section
 - 3. Fan section
- C. General:
 - 1. Factory assembled air-handling unit that is modular in design and construction. Unit may consist of a fan and coil section with factory-installed chilled water or direct expansion coil, preheat or reheat coil, heating coil section, filter section, combination filter/mixing box (flat or V-bank arrangement), or access section(s) as indicated on the equipment schedules.
- D. Unit Cabinet:
 - 1. Unit panels shall be constructed of 20-gauge G40 galvanized steel and shall be capable of withstanding 125-hour salt spray test per ASTM Standard 117. All casing panels shall be removable for easy access to the unit. All panels shall be gasketed to ensure a tight seal.
 - 2. Double wall unit panels (includes corner posts, mullions and access doors) shall be 1-in. nominal thickness using 1.5-lbs/ft³ fiberglass insulation between galvanized steel panels.
 - 3. Insulation shall be secured to casing with water based adhesive, and weld pins where necessary, corresponding to 25/50-flame spread/smoke developed.
 - 4. Condensate drain pans shall be sloped to prevent standing water and shall be constructed of 18-gauge G40 galvanized steel or stainless steel; they shall have a galvanized steel or stainless steel male pipe threaded drain connection.
- E. Fan Section:
 - 1. Fan sections shall be constructed of G40 steel and shall have a formed channel base for integral mounting of fan, motor, and casing panels. Fan housing, wheel, shaft, and bearings shall be rigidly secured to the base unit.
 - 2. Fan decks shall be internally spring isolated (one-inch deflection) with the fan outlet connection to be made using canvas duct.
 - 3. Each unit shall have one fan wheel and housing only.

4. Fan wheels shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected to operate at least 25% below the first critical speed, and shall be statically and dynamically balanced as an assembly.
 5. Fan shafts shall be solid steel, turned, ground and polished.
 6. Fan bearings shall be self-aligning, non-regreasable (permanent) ball bearing type selected for an average life (L50) of 100,000 hours at design operation conditions, per ANSI Code B3.15.
 7. Fan motor shall be mounted within the fan section casing. Motor shall be NEMA Design B with sizes and electrical characteristics as shown on the equipment schedule.
 8. Fan drive shall be designed for a minimum of 1.15 service factor and shall be factory mounted and aligned. Belt drive package shall be variable-pitch type (constant volume) or fixed-pitch type (variable volume).
- F. Coil Sections:
1. All coils shall have aluminum plate fins mechanically bonded to 1/2-in. OD seamless copper tubes by mechanical expansion. Coils shall be factory leak tested at 450-psig air pressure under water in an illuminated test tank. Copper tubes shall be either 0.016" or 0.025" copper tube wall thickness. Coils shall have G40 galvanized steel or stainless steel casings with copper headers and sweat connections.
 2. Chilled water coils shall have a working pressure of 450-psig at 200°F. No turbulence-promoting devices will be permitted inside the tubes. Headers shall have vent connections.
 3. Hot water coils shall have a working pressure of 450-psig at 200°F. No turbulence-promoting devices will be permitted inside the tubes. Headers shall have vent connections.
- G. Filter Sections:
1. Each filter section shall be designed and constructed to house the specific type of filter specified on the equipment schedule.
- H. Access Stations:
1. Access sections shall be installed where indicated on the drawings and shall be as specified on the equipment schedule.
 2. Access sections shall have removable access panels.
- I. Special Features: The following shall be included:
1. Fan Section:
 - a. Variable frequency drives.
 - b. Motor starters – contactor with overload for three phase and contactor for single phase.
 - c. High-efficiency motors (inverter-duty).
 - d. Totally enclosed fan cooled (TEFC) motors (inverter-duty).
 - e. Class II forward curved fans with regreasable pillow block bearings.
 - f. Provide with factory mounted non-fused disconnect.
 2. Coil Section:
 - a. Chilled water coil with copper plate fins and/or stainless steel casing.
 - b. Hot water coil with copper plate fins and/or stainless steel casing.
 3. Access Doors: Hinged (lift-off type) doors with quick-action latches (handles) on both sides of the section for access to both the fan and filter from either side of the unit.

4. Base Rail: Unit mounted base rail shall be a minimum of 4" in height and constructed of galvanized steel, structurally capable of supporting unit on floor or by ceiling suspension.

J. Unit Controls

1. Units controlled solely by factory provided controls with BACnet interface shall not be acceptable.
2. A third-party device interfaces to a terminal strip. The third party is required to directly control the following: supply fan, exhaust fan, dampers, cooling and heating enable, dehumidification enable, temperature setpoints, and emergency shutdown.
3. Operating protocol: The DDC shall be factory-programmed for BACnet IP.
4. Variable Frequency Drive (VFD) - Unit shall have factory installed variable frequency drives for modulation of the supply air and exhaust air blower assemblies. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
5. Airflow monitoring required through thermistor or low-pressure transducer in all airstreams. Feedback from VFD frequency converted to airflow is not acceptable

2.2 PACKAGED ROOF TOP HEATING COOLING UNIT (3-12.5 TONS)

A. Manufacturers:

1. Johnson Controls

B. Configurations: Hot Water Heating; DX Cooling

C. General: Unit shall be factory assembled, piped, internally wired and fully charged with refrigerant. Unit shall be designed to operate at outdoor ambient temperatures as high as 115 degrees F. Cooling and heating capacities shall be rated in accordance with ARI standards. Unit design shall be certified by the CSA specifically for outdoor applications using propane or natural gas. Unit shall be designed for outdoor rooftop level installation.

D. Casings: Unit casing shall be Double Wall, heavy gauge galvanized steel with exterior surfaces painted. Unit casing shall be capable of withstanding 750- hour salt spray exposure per ASTM B117 (scribed specimen). All panels shall be heavy gauge steel, gasketed, and insulated. Fiberglass insulation with thermal conductivity of 0.23 or better, adhered with water-based adhesive shall be installed. Removable, hinged access or service panels shall be provided for access.

E. Refrigeration System: Refrigeration controls shall include condenser fan, evaporator fan, and compressor contactors, and 24-volt transformer. Each circuit shall have a separate set of refrigerant controls. Safety controls shall be an internal, motor overload device. Refrigerant shall be R-454B.

1. Compressors: Unit shall use fully hermetic scroll compressors for each independent refrigeration circuit.
 - a. Motors shall be cooled by refrigerant gas passing through motor windings.
 - b. Two stage 6-ton models shall use fully hermetic, 2-stage compressors.
 - c. Compressors shall be internally protected from high discharge temperature conditions.
 - d. Compressors shall be factory mounted on rubber grommets.

- e. Crankcase heaters shall be installed in the factory as needed on tandem compressor sets.
 - 2. Evaporator Coils, Aluminum Fin- Copper Tube: Standard evaporator coils shall have aluminum plate fins mechanically bonded to seamless internally grooved copper tubes with all joints brazed.
 - a. Microchannel condenser coils shall be leak tested to 150 psig, pressure tested by supplier to 600 psig, and burst qualified to CSA C22.2 No. 60335-2-40.
 - b. Assembled unit shall be pressure tested to 450 psig.
 - 3. Drain Pan: Shall be a multidirectional internally sloped condensate drain pan made of a non-corrosive material. Shall comply with ASHRAE Standard 62. Shall use a 1" NPT female drain connection through the side of the drain pan. Connection shall be made per manufacturer's recommendations.
 - 4. Hot Water Heating Coils: Standard condenser coils shall have all aluminum microchannel design consisting of aluminum multiport flat tube design and aluminum fin. Coils shall be a furnace brazed design and contain epoxy lined shrink wrap on all aluminum to copper connections.
 - a. Shall be leak tested to 150 psig, pressure tested to 650 psig, and qualified to UL 1995 burst test at 1980 psig.
 - b. Assembled unit shall be pressure tested to 400 psig.
- F. Fans
- 1. Supply Air Fan: Shall be standard belt drive assembly with an adjustable pitch motor pulley.
 - a. Shall use sealed, permanently lubricated ball-bearing type.
 - b. Blower fan shall be double-inlet type with forward-curved blades.
 - c. Shall be constructed from steel with corrosion resistant finish and dynamically balanced.
 - d. 6.5 ton models and above shall have a Variable Frequency Drive (VFD) installed inside the unit cabinet, mounted, wired, and tested.
 - e. VFD shall have controller for VAV Operation
 - 2. Condenser Fans: Shall be direct driven propeller-type fan. Shall have aluminum blades riveted to corrosion-resistant steel spider brackets and be dynamically balanced.
- G. Filters: 2" pleated MERV 13 filters, in quantity and size to fit unit filter rack.
- H. Heating Systems: Hot Water heating section shall be a completely assembled, wired and piped, hot water heating system within the unit. Design shall be certified by CSA specifically for outdoor application. Threaded gas connections.
- I. Electrical Connections:
- 1. Single Point Power Connection
- J. Accessories
- 1. Disconnect Switch, Factory Installed: Unit Mounted, Non-Fused Disconnect Switch:
 - a. Switch shall be factory installed, internally mounted.
 - b. National Electric Code (NEC) and UL approved non-fused switch shall provide unit power shutoff.
 - c. Shall be accessible from outside the unit
 - d. Shall provide local shutdown and lockout capability

- 2. Downflow Economizer, Factory Installed: Enthalpy controlled 100% economizer shall automatically use outdoor air for free cooling when outdoor air temperature and humidity are at acceptable levels.
 - a. Barometric relief shall be provided
- K. Controls: Units shall have open communication protocols with all required points exposed. Protocols supported include: BACnet®, MS/TP, Modbus®, and N2 communication. Provide terminal strip.
- L. Warranty: Provide standard one-year complete unit parts warranty and 2-5 years compressor parts warranty.
- M. Curb: Refer to Specification Section 230100.

2.3 PACKAGED ROOF TOP AIR CONDITIONING UNITS

- A. Manufacturers:
 - 1. JCI/York
 - 2. Addison
 - 3. Greenheck Fan Corporation
 - 4. Aeon
- B. Configuration:
 - 1. Return Plenum/economizer section
 - 2. Filter section
 - 3. Cooling reheating coil section
 - 4. Fan section
- C. General:
 - 1. The unit shall be a packaged factory assembled heating and/or cooling system. The unit shall include all factory wiring with a single point power connection, phase and voltage monitor, refrigerant piping and charge (R-410A), operating oil charge. Dual refrigerant circuits (sizes 120-840), shall include a microprocessor based control system. The unit shall, based on project requirements, include all special features necessary to provide fully conditioned ventilation air at neutral conditions to the building.
- D. Unit Cabinet:
 - 1. Double wall design, constructed of C-90 galvanized steel, bonderized primed on exterior and interior and pre-coated with a polyester pre-coat finish on exterior.
 - a. Top cover shall be a minimum 20-gauge sheet metal with 2.0-in. thick, closed cell polyisocyanurate foam insulation (R-13) with a 24-gauge sheet metal interior liner.
 - b. Access panels shall be a minimum of 20-gauge sheet metal with 2.0-in. thick, closed cell polyisocyanurate foam insulation with a 24-gauge sheet metal interior liner. Fastening screws shall be Maniguard coated for corrosion resistance.
 - c. Base pans shall be 16-gauge galvanized steel insulated with 0.375-in. thick, closed cell foam insulation to provide a thermal barrier and seal against the roof curb. All openings through the base pan shall have upturned flanges at least 1.5 inches in height with sealed corners.

- d. Condensate pan shall be double sloped, single wall 20-gauge stainless steel with welded corners and insulated with 1 inch closed cell neoprene insulation.
 - e. Base rail shall be 6" C channel 12-gauge galvanized steel G-90 and bolted (A, B, and C cabinet) or 6" tubular welded closed section structural steel tubing (D and E cabinet).
 - f. Roof sections shall be sloped for proper drainage and include drip edge.
 - 2. Unit casing shall be capable of withstanding up to 2,500-hour salt spray exposure per ASTM B117.
 - 3. Unit shall have insulated access doors, for easy access to the controls compartment and all other areas requiring servicing. Each door shall seal against a triple edge co-extruded EDPM gasket to help prevent air and water leakage and for ease and safety during servicing. Access doors shall include a thermal break. Access doors shall be equipped with stainless steel piano hinges and quarter turn, adjustable, lockable by tool, draw tight cam-action latches.
 - 4. Door stays.
 - 5. Unit shall have provisions in frame rails to facilitate overhead rigging.
 - 6. Filters shall be accessible through a hinged access panel.
 - 7. The outdoor air opening shall have a factory provided hood with bird screen. Exhaust hoods shall be included with the economizer and/or exhaust options.
- E. Fans:
- 1. Indoor Supply, Return/Exhaust Fans:
 - a. ECM type assembly is base mounted and external rotor fan with backward curved blades of high-performance composite material. Fan assembly shall be statically and dynamically balanced at the factory as a single rotating assembly to a quality level of G=6.3 in accordance with DIN ISO 1940-1.
 - 2. Condenser Fan and Motor fully assembled by manufacturer:
 - a. Fans shall be external rotor direct driven axial fans with a minimum 5-1/2" power coated spun venturi for high efficiency and low noise, with powder coated sickle shaped blades.
 - b. The fan motor TEAO, totally enclosed air over, assembly shall be end mounted to a structurally powder coated rigid welded finger guard.
 - c. Fans shall be VFD driven for controlling head pressure. Low ambient operation is 0°F.
 - d. Fans shall discharge air vertically upward and finger guard shall be powder coated.
 - e. Fans shall be statically and dynamically balanced as an assembly to a quality level of G=6.3 in accordance with DIN ISO 1940-1.
- F. Compressors:
- 1. Fully hermetic, scroll type compressors with overload protection and short cycle protection with minimum on and off timers. Time delay relay 5 minute minimum ON run time for proper oil level and compressor operation.
 - 2. Compressor shall be installed in an insulated compartment accessible through hinged access doors for sound mitigation. Exposed compressors must be applied with sound blankets for sound mitigation.
 - 3. Line voltage, low voltage operating controls, refrigerant circuit access points, refrigerant flow control devices and compressors shall be accessible from a single location behind stainless steel piano hinged access doors for ease of service.
 - 4. Compressors shall be mounted on rubber in shear isolators and refrigerant lines to include reaction torque loops.

5. Reverse rotation protection shall be provided for all compressors and all 3 phase motors in the unit.
 6. Crankcase heaters shall only be activated during compressor off mode.
 7. Options: Variable Capacity Compressor(s):
 - a. On circuits from ten (10) tons and larger a variable capacity compressor with a variable speed drive shall be available on the lead refrigeration circuit. The control system shall be capable of unloading the compressor in an unlimited number of steps for capacity control. Unit sizes 480 and larger have tandem type compressors. The lead compressor shall include a variable speed drive and staging control for remaining compressors for capacity control.
- G. Refrigerant Components:
1. Unit shall be equipped with single refrigerant circuit (sizes 036-096) or dual refrigerant circuits (sizes 120 and up) with each circuit containing:
 - a. Solid core filter drier.
 - b. Field adjustable externally equalized thermostatic expansion valve.
 - c. Service access ports.
 2. Unit shall be equipped with VFD-controlled variable condenser fan speed operation for head pressure control to allow low ambient operation down to 0°F.
- H. Coils:
1. Standard evaporator coil shall have enhanced surface aluminum since wave fins mechanically bonded to seamless internally grooved 3/8" diameter (ABC cabinets) 1/2" diameter (D,E cabinets) copper tubes, .012" tube wall thickness with brazed tube joints. Evaporator coils shall be minimum six (6) row with intertwined circuiting. Stacked coils shall be intertwined circuiting for the full face area to be active and prevent any stratified air temperatures from occurring.
 2. Air Cooled Condensing Coil, Cooling only duty: microchannel floating microchannel condenser coil mounting design with rubber isolation and glide path for coil expansion and contraction. Rigid mounted microchannel condenser coils are not acceptable.
 3. Modulating Hot Gas Reheat: A factory-installed hot gas reheat (HGRH) coil shall be available. The HGRH coil shall be an available option on the lead circuit only or with a dual circuit coil for reheat both refrigerant circuits. Precise leaving DX coil air temperature sensor and control prior to reheat coil, for verification of proper de-humidification operation, as well as ease of troubleshooting and diagnostics. Saturated Suction Temperature control is inadequate and not acceptable.
- I. Filter Section:
1. Filter section shall be supplied with 4-in. thick MERV-13 pleated media filters.
- J. Controls and Safeties:
1. Terminal Strip controls for field supplied and installed controls.
- K. Unit Controls
1. Units controlled solely by factory provided controls with BACnet interface shall not be acceptable.
 2. Unit shall incorporate heat-cool only controls to allow third-party control of a packaged DX unit while maintaining the safeties of the refrigeration system and heating devices. This

controller is responsible for the operation of the refrigeration and heating components installed in the unit. The safety of the refrigeration system is assured by monitoring pressures and temperatures contained within the refrigeration circuit(s).

3. A third-party device interfaces to the Heat-Cool Only controller via a terminal strip. The third party is required to directly control the following: supply fan, exhaust fan, dampers, cooling and heating enable, dehumidification enable, temperature setpoints, and emergency shutdown.
4. Operating protocol: The DDC shall be factory-programmed for BACnet IP.
5. Variable Frequency Drive (VFD) - Unit shall have factory installed variable frequency drives for modulation of the supply air and exhaust air blower assemblies. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
6. Airflow monitoring required through thermistor or low-pressure transducer in all airstreams. Feedback from VFD frequency converted to airflow is not acceptable

L. Electrical Requirements:

1. All unit power wiring shall enter unit cabinet at a single location with a single power point connection.
2. Control panel shall incorporate "Touch-safe" design.
3. Phase/Voltage Monitor: A factory-installed over/under-voltage and phase loss sensor shall stop the unit whenever voltage exceeds allowable range, phases are out of sequence, or a phase is dropped. The unit will restart automatically after a delay of five (5) minutes after the correct power is supplied. Display shall be capable of archiving and display of last four (4) faults modes.
4. Convenience Outlet: Shall be factory-installed and internally mounted with an externally accessible 115-v, 15 amp GFCI, female receptable with hinged cover. Factory-wired GFI with a step-down transformer and 15.0 amp breaker.
5. NEMA 3R Non-Fused Disconnect Switch: Shall be factory-installed, externally mounted, and UL approved. Non-fused switch shall provide power off lockout capability.
6. Unit panel shall carry 65 KA SCCR rating. Unit sub wiring including contractors and motor starter protector rated at a minimum of 65KA. Over current protection devices for VFD's and ECM blowers are upgraded to fuses per manufacturers specs to increase the rating to a minimum of 65k.

M. Motors:

1. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have either internal line break thermal and current overload protection or external current overload modules with compressor temperature sensors.
2. All condenser fan motors shall be totally enclosed air-over (IP54) with permanently lubricated ball bearings, class F insulation and manual reset overload protection.
3. Standard indoor fan motors shall be open drip proof design. Optional totally enclosed fan-cooled motors are available.

N. Unit Accessories:

1. Dampers: Outside Air Damper, and Return Air Damper
 - a. Factory mounted AMCA Class 1A certified, low leakage airfoil control dampers. Frame shall be one-piece uniframe construction of 16 ga. (1.6) galvanized steel roll formed hat channel structurally equivalent to a minimum 13 ga. (2.4) frame. Blades

shall be 14 ga. (2.0) equivalent galvanized steel, roll-formed airfoil type for low pressure drop and low noise generation.

- b. Bearings shall be 304 stainless steel, oil impregnated, and self-lubricating sleeve type with a 450 pound (204 kg) minimum radial crush load.. Damper shall be tested and licensed in accordance with AMCA 511 for Air Performance and Air Leakage. Damper widths from 12" to 60" (305 to 1524) wide shall not leak any greater than 3 cfm/sq.ft. at 1" w.g. (15.2 l/s-m2 at .25 kPa).
- c. Dampers: Exhaust Air Damper:
 - 1) Standards: Frame shall be 20 gauge (1.0) roll-formed galvanized steel. Blades shall be 28 gauge (.50) roll-formed galvanized steel. Backdraft dampers shall be designed for maximum 3,000 fpm face velocities.

O. Roof Curbs:

- 1. Curbs shall be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
- 2. Curb shall be provided with a vibration isolation rail assembly.
- 3. Curb shall be provided with acoustical panels.
 - a. General: Acoustical Panel shall be factory laminated construction as manufactured by Kinetics Noise Control or equal.
 - b. Materials: Panel layers shall be comprised of 2" 3PCF AcoustiBoard fiberglass and 5/8" AcoustiSheet as manufactured by Kinetics Noise Control or equal.
 - c. Acoustical Panels: All panels and their components shall be pre-fabricated, sectional, and modular; designed for easy and accurate field assembly.
 - d. Panel Construction: All panels shall be 7-1/4" inches thick (min), comprised of alternating layers of 2" fiberglass absorption panels and 5/8" acoustically dampened sheetrock.

2.4 MAKE-UP AIR UNIT (MAU) PACKAGED ROOFTOP VENTILATORS - HEATING/COOLING

A. Manufacturers:

- 1. JCI/York
- 2. Addison
- 3. Greenheck Fan Corporation
- 4. Aaon

- B. Description: Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, downturn outdoor air intake with 2" aluminum mesh filter assembly, hot gas reheat coil, indirect gas-fired furnace, packaged DX system, phase and brownout protection, motorized dampers, curb assembly, filter assembly intake air, supply air blower assembly, and an electrical control center. All specified components and internal accessories factory installed are tested and prepared for single-point high voltage connection except with electric post heat and exhaust fan only power which have dual point power

C. CABINET

- 1. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.

- a. Unit's exterior shall be supplied from the manufacturer using G60 galvaneal steel with proprietary pre-painted material in the following finish color; Concrete Gray-RAL 7023. This has been subjected to a salt spray test per ASTM-B117 and evaluated using ASTM-D714 and ASTM-D610 showing no observable signs of rust or blistering until reaching 2,500 hours. Uncoated galvanized steel exterior is not acceptable.
 - b. Internal assemblies: 24 gauge, galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
2. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - a. Materials: Rigid urethane injected foam. Foam board not acceptable.
 - 1) Thickness: 2 inch (50.8 mm)
 - 2) Thermal Resistance R13
 - 3) Thermally broken
 - 4) Meets UL94HF-1 flame requirements.
 - 5) Location and application: Full coverage of entire cabinet exterior to include walls, roof of unit, unit base, and doors.
 - b. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - 1) Thickness: 2 inch (50.8 mm)
 - 2) Thermal Resistance R8
 - 3) Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - 4) Location and application: Divider panels between outdoor air and return air/exhaust air streams.
3. Roof Insulation: 2 inch (50.8 mm) fiberglass located above the 1 inch (25.4 mm) foam panel.
4. Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 18 gauge galvanized G90 steel or painted galvanized steel.
5. Supply Air blower assemblies: Blower assembly shall consist of an electric motor and direct-drive fans. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motors shall be capable of continuous speed modulation and controlled by a VFD.
6. Evaporator Coil: Evaporator coil shall be (silver) soldered or brazed into the compressed refrigerant system. Coil shall be a single circuit design. constructed of copper tubing, permanently bonded to aluminum fins and enclosed in a galvanized steel frame.
7. Control panel / connections: Units 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. RTU shall be equipped with a Unit Disconnect Switch.
8. Condensate drain pan: Drain Pan shall be an integral part of the unit whenever a cooling option is included. Pan shall be formed of welded austenitic stainless steel sheet material and provided with a welded stainless steel drain connection at the front for connection to a P trap. Drain pan shall be sloped in two directions to provide positive draining and drain connector shall be sealed at penetration through cabinet wall.
9. P trap: If the unit is equipped with a condensate drain pan, contractor shall provide, or fabricate, and install an appropriate P trap, in accordance with all local and area codes and Best Practices.

10. Reheat coil shall be an all-aluminum micro channel design with factory installed modulating hot gas reheat valve.
11. Indirect gas furnace
 - a. Shall be ETL Certified as a component of the unit.
 - b. Shall have an integral combustion gas blower.
 - c. Shall be ETL Certified for installation downstream of a cooling coil.
 - d. Shall have fault sensors to provide fault conditions to optional digital controller or building controls.
 - e. Shall have 4-pass tubular heat exchangers, constructed of type 409 stainless steel. Heat exchanger tubes shall be installed on the vest plate by means of swaged assembly, welded connections are not acceptable. Heat exchanger tubes shall be supported by a minimum of two fabricated assemblies that support the tubes and also permit expansion and contraction of the tubes.
 - f. Heat exchanger shall have a 25 year extended warranty.
 - g. Furnace control shall be 4:1 Modulating.
 - h. Shall be encased in a weather-tight metal housing with intake air vents. Large, metal lift-off door shall provide easy access to the enclosed vest plate, control circuitry, gas train, burner assembly and exhaust blower.
 - i. Shall have solid state controls permitting stand-alone operation or control by building controllers.
12. Packaged DX System: Unit shall have an integral compressor(s) and evaporator coil located within the weather-tight unit housing. Condenser coils shall be all-aluminum micro channel design appurtenant condenser fan assemblies shall be factory installed as integral subassemblies of the unit and mounted on the unit's exterior. Lead condenser fan(s) will have an electronically commutated (EC) motor that will modulate to maintain a head pressure set point.] Motors shall be UL Recognized and CSA Certified. The lead refrigerant compressor shall be inverter hermetic scroll-type. Additional compressor shall be single stage hermetic scroll-type paired in tandem with lead inverter compressor. Compressors shall be equipped with liquid line filter drier, electronic expansion valves (EEV) or thermostatic expansion valves (TXV) on non-inverter compressor circuits, manual reset high pressure and low pressure cutouts and all appurtenant sensors, service ports, leak detection sensors and safety devices. Compressed refrigerant system shall be fully charged with R-454B refrigerant. Compressors shall be mounted within an insulated access compartment and on a raised cabinet shelf to reduce sound and vibration. Each compressor shall be factory-equipped with an electric crankcase heater to boil off liquid refrigerant from the oil.
13. Condenser Fans: Fan blades must be constructed of aluminum or a composite material and have a geometry designed and documented to reduce sound and energy when compared to a traditional rectangular blade fan. Traditional rectangular blade fans are not allowed due to increased noise generated and increase power utilized. Condenser fan motors shall be three phase, external rotor, type 56 frame, open air over and shaft up. Each condenser fan motor shall have a vented frame, rated for continuous duty and be equipped with an automatic reset thermal protector. Lead condenser fan(s) will have an electronically commutated (EC) motor that will modulate to maintain a head pressure set point.] Motors shall be UL Recognized and CSA Certified. Single condenser fan running at max RPM and design static pressure shall not exceed an A-weighted sound power level of 75 db at free inlet/outlet test conditions.

14. Packaged DX Control and Diagnostics: The Packaged DX system shall be controlled by an onboard digital controller (DDC) that indicates both owner-supplied settings and fault conditions that may occur. The DDC shall be programmed to indicate the following faults:
 - a. Global alarm condition (active when there is at least one alarm)
 - b. Supply Air Proving alarm
 - c. Compressor Trip alarm
 - d. Compressor Locked Out alarm
 - e. Supply Air Temperature Low Limit alarm
 - 1) Sensor #1 Out of Range (outside air temperature)
 - 2) Sensor #2 Out of Range (supply air temperature)
 - 3) Sensor #3 Out of Range (cold coil leaving air temperature)
15. Phase and brownout protection: Unit shall have a factory-installed phase monitor to detect electric supply phase loss and voltage brown-out conditions. Upon detection of a fault, the monitor shall disconnect supply voltage to all motors.
16. Motorized dampers / Intake Air, Motorized dampers of low leakage type shall be factory installed.
17. Curb Assembly: A curb assembly made of 14 gauge galvanized steel shall be provided by the factory for assembly and installation as part of this division. The curb assembly shall provide perimeter support of the entire unit and shall have duct adapter(s) for supply air. Curb assembly shall enclose the underside of the unit and shall be sized to fit into a recess in the bottom of the unit. Contractor shall be responsible for coordinating with roofing contractor to ensure curb unit is properly flashed to provide protection against weather/moisture penetration. Contractor shall provide and install appropriate insulation for the curb assembly. The curb shall be the height of 18 in.
18. Bipolar Ionization: Needlepoint bipolar ionizer is factory mounted and provides air disinfection. The ionizer is on when there is power to the unit disconnect.

D. BLOWER

1. Blower section construction, Supply Air: direct drive motor and blower shall be assembled on a 14 gauge galvanized steel platform and shall be equipped with 1.125 inch thick 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. Fan: Direct drive, airfoil plenum fan with aluminum wheel statically and dynamically balanced. Prop or belt-drive fan not acceptable due to low static capabilities.
4. Blades: Welded aluminum blades only.
5. Blower section motor source quality control: 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 1/2 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPart minimum energy-efficiency standards for single speed ODP and TE 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.
2. Motors shall be 60 cycle, 3 phase 208 volts.

F. UNIT CONTROLS

1. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors or it can be operated as a heating and cooling system controlled by a Building Management System (BMS). This unit shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors.
2. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified ventilating conditions can be input by means of pushbuttons.
3. Unit supply fan shall be configured for network control.
4. Unit exhaust fan shall be configured for
5. Outside Air / Return Air damper control shall be
6. Operating protocol: The DDC shall be factory-programmed for BACNetIP.
7. Variable Frequency Drive (VFD): unit shall have factory installed variable frequency drive for modulation of the exhaust air blower assembly. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
8. Airflow monitoring required in the supply airstreams.

G. FILTERS

1. Unit shall have permanent 2 inch (50.8 mm) aluminum 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 supply air stream. MERV 13 disposable pleated filters shall be provided in the supply final air stream.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in conformance with ARI 435.
- C. Install assembled units on vibration isolators.
- D. Install assembled units on curb rail vibration isolators.

3.2 EXAMINATION AND COORDINATION

- A. General: Install energy recovery units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Connections: Install piping and ductwork to allow service and maintenance.

- C. Cleaning:
 - 1. After completing system installation and testing, inspect exposed finishes. Clean and remove burrs and construction debris, repair damaged finishes.
 - 2. Vacuum equipment interior to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils.
- D. Field Quality Control and Testing: Operational Test: Upon completion of inspection, testing, and start-up, test system for proper operation and system capacity. Repair malfunctions and/or replace components. Re-test equipment until proper operation is achieved.
- E. Start-Up: Provide services of a factory trained representative to start-up equipment. Contractor shall assist and cooperate with factory representative as required. Coordinate start-up with TAB & ATC Contractors. Start-up equipment in accordance with manufacturer's instructions. Refer to Section 230990, "Testing, Adjusting, and Balancing" for additional start-up procedures.
 - 1. Ensure filters are installed prior to initial start-up; do not start-up or operate equipment without filters in place. Filters shall remain in place through the duration of construction
 - 2. Provide and install new filters upon turnover to Owner.
 - 3. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- F. Training: Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of rooftop air handling units. Training to include start-up and shut-down, servicing, and preventative maintenance schedules and procedures, and troubleshooting procedures, and procedures for obtaining replacement parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals specified in Division One. Schedule 4 hours of training with Owner, schedule at least 7-days prior notice.
- G. Demonstration: After completion of inspections, installation, and testing, Contractor shall perform the following demonstration inspections and tests in the presence of the Engineer and Owner.
 - 1. Verification of proper installation
 - 2. System functional and safety tests
 - 3. System operational tests

END OF SECTION 230855

SECTION 230860 - VENTILATION EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Roof Exhausters
- B. Ceiling Exhaust Fans
- C. Inline Exhaust Fans
- D. Kitchen Hood Exhaust Fans
- E. Gravity Relief Ventilators

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 230010.
- 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 DIRECT DRIVE ROOF DOWNBLAST CENTRIFUGAL EXHAUST FANS (TYPE R)

- A. Manufacturers:
 - 1. Basis of Design: Greenheck Model G
 - 2. Acceptable Substitutes: PennBarry, Cook

- B. General Description:
1. Downblast fan shall be for roof mounted applications.
 2. Performance capabilities up to 14,500 cubic feet per minute (cfm) and static pressure to 2.75" of water gauge.
 3. Fans are available in twenty sizes with nominal wheel diameters ranging from 8" through 30" (071 – 300-unit sizes)
 4. Maximum continuous operating temperature is 180°F (82.2°C)
 5. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number.
- C. Wheel:
1. Constructed of Composite
 2. Non-overloading, backward inclined centrifugal
 3. Statically and dynamically balanced in accordance with AMCA Standard 204-05
 4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
- D. Motors:
1. Electronically Commutated Motor
 - a. Motor enclosure: ODP
 - b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: haded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3-phase induction type motors
 - c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase
 - d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor
 - e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal
 - f. Motor shall be a minimum of 85% efficient at all speeds
- E. Housing:
1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum
 2. Shroud shall have an integral rolled bead for extra strength
 3. Shroud shall be drawn from a disc and direct air downward
 4. Lower windband shall have a formed edge for added strength
 5. Motor cover shall be drawn from a disc
 6. All housing components shall have final thicknesses equal to or greater then preformed thickness
 7. Curb cap shall have pre-punched mounting holes to ensure correct attachment
 8. Rigid internal support structure
 9. Leak proof
- F. Housing Supports and Drive Frame: Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.

- G. Vibration Isolation:
 - 1. Rubber isolators
 - 2. Sized to match the weight of each fan
- H. Disconnect Switches:
 - 1. NEMA rated: NEMA 1: indoor application no water. Factory standard.
 - 2. Positive electrical shut-off
 - 3. Wired from fan motor to junction box installed within motor compartment
- I. Options and Accessories:
 - 1. Birdscreen:
 - a. Material Type: Galvanized
 - b. Protects fan discharge
 - 2. Roof Curbs:
 - a. Type: GPI - Welded, straight sided curb with 2" of flashing flange and wood nailer
 - b. Mounted onto roof with fan
 - c. Material: Galvanized
 - d. Insulation thickness: 1"
 - 3. Dampers:
 - a. Type: BD-100, Gravity
 - b. Prevents outside air from entering back into the building when fan is off
 - c. Balanced for minimal resistance to flow
 - d. Galvanized frames with pre-punched mounting holes

2.2 UPBLAST EXHAUST FANS (Type U)

- A. Manufacturers:
 - 1. Basis of Design: Greenheck CUE or CUBE
 - 2. Acceptable Substitutes: PennBarry, Cook
- B. General Description:
 - 1. Discharge air directly away from the mounting surface.
 - 2. Maximum continuous operating temperature for fan sizes 098-300 is 400°F (204.4°C) and for fan sizes 060-095 is 160°F (71.1°C)
 - 3. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number
- C. Wheel:
 - 1. Material Type: Aluminum
 - 2. Non-overloading, backward inclined centrifugal wheel
 - 3. Statically and dynamically balanced in accordance with AMCA Standard 204-05
 - 4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
- D. Motors:
 - 1. Electronically Commutated Motor
 - a. Motor enclosure: Open drip proof

- b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3-phase induction type motors
 - c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase
 - d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor
 - e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal
 - f. Motor shall be a minimum of 85% efficient at all speeds
- E. Housing:
 - 1. Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband, and motor compartment housing. Galvanized material is not acceptable
 - 2. Housing shall have a rigid internal support structure
 - 3. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing
 - 4. Windband to include an integral rolled bead for strength
 - 5. Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting, and caulking are not acceptable
 - 6. Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to curb
 - 7. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators
 - 8. Breather tube shall be 10 square inches in size for fresh air motor cooling, and designed to allow wiring to be run through it
- F. Motor Cover: Constructed of aluminum
- G. Vibration Isolation:
 - 1. Double studded or pedestal style true isolators
 - 2. No metal-to-metal contact
 - 3. Sized to match the weight of each fan
- H. Disconnect Switches:
 - 1. NEMA rated: NEMA 1: indoor application no water. Factory standard.
 - 2. Positive electrical shut-off
 - 3. Wired from fan motor to junction box installed within motor compartment
- I. Options and Accessories:
 - 1. Roof Curbs:
 - a. Type: GPI Welded, straight sided curb with 2" of flashing flange and wood nailer
 - b. Mounted onto roof with fan
 - c. Material: Galvanized
 - d. Insulation thickness: 1"
 - 2. Curb Seal:

- a. Foam Seal – dense foam tape seal
- 3. Hinge Kit (Grease applications only):
 - a. Aluminum Hinges
 - b. Allows the fan to tilt away for access to wheel and ductwork for inspection and cleaning.
- 4. Dampers (Non-grease applications only):
 - a. Type: BD-100, Gravity
 - b. Prevents outside air from entering back into the building when fan is off
 - c. Balanced for minimal resistance to flow
 - d. Galvanized frames with pre-punched mounting holes

2.3 DIRECT DRIVE PREMIUM CEILING MOUNTED CENTRIFUGAL EXHAUST FANS (Type C)

- A. Manufacturers:
 - 1. Basis of Design: Greenheck Model SP-VG
 - 2. Acceptable Substitutes: PennBarry, Cook
- B. General Description:
 - 1. Base fan performance at standard conditions (density 0.075 Lb/ft³)
 - 2. Ceiling mounted applications
 - 3. Maximum operating temperature is 130°F (54.4°C)
 - 4. Constant CFM
 - 5. Fans are UL/cUL listed 507 - Electric Fans
 - 6. Energy Star Most Efficient
 - 7. ASHRAE 62.2
 - 8. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number
- C. Wheel:
 - 1. Forward curved centrifugal wheel
 - 2. Constructed of polypropylene.
- D. Motors:
 - 1. Motor enclosures shall be Totally Enclosed (TE)
 - 2. Motors shall be permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase
 - 3. Overload Protection
 - 4. EC Motor
- E. Housing: Constructed of heavy gauge galvanized steel
- F. Aluminum Backdraft Damper: Prevents air from entering back into building when fan is off
- G. Outlet: Round
- H. Grille:
 - 1. Type: Standard
 - 2. Constructed of high impact polystyrene.

- I. Mounting Brackets: Fully adjustable for multiple installation conditions.
- J. Options and Accessories:
 - 1. Control/Operation:
 - a. Two speed with adjustable lower CFM setting
 - 2. Flat Roof Caps:
 - a. Model RCC-7, Curb Cap - weathertight aluminum construction, integral birdscreen, built in curb cap which require roof curb

2.4 RELIEF GRAVITY VENTILATOR (RV)

- A. Manufacturers:
 - 1. Basis of Design: Greenheck
 - 2. Acceptable Substitutes: PennBarry, Cook
- B. Fabra Hood Intake Gravity Ventilator - Greenheck Model FG
 - 1. General Description:
 - a. Ventilator is low silhouette for intake applications with natural gravity or negative pressure system
 - b. Selection based on non-ducted applications
 - c. Intake units with throat widths through 42 inches are ship assembled when throat lengths do not exceed 84 inches
 - d. Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number
 - 2. Hood and Base:
 - a. Material Type: Aluminum
 - b. Hood Constructed of precision formed, arched panels with interlocking seams
 - c. Vertical end panels are fully locked into hood end panels
 - d. Base height is standard of 5 inches
 - e. Curb cap is six inches larger then throat size
 - f. Curb cap has pre-punched mounting holes for installation
 - 3. Birdscreen:
 - a. Constructed of ½ inch Aluminum mesh
 - b. Mounted horizontally across the intake area of the hood
 - 4. Hood Support:
 - a. Constructed of galvanized steel and fastened so the hood can either be removed completely from the base or hinged open
 - 5. Options/Accessories:
 - a. Roof Curbs:
 - 1) Type: GPI or GPIIP
 - 2) Mounted onto roof with fan
 - 3) Material: Aluminum
 - 4) Insulation thickness: 1 inches
 - b. Extended Base:
 - 1) Seven inch extension to base height making overall base twelve inches tall.
 - 2) Raises the hood further above the roof deck to prevent snow or moisture intake.
 - c. Curb Seal:

- 1) Rubber seal between fan and the roof curb
- d. Dampers:
 - 1) Type: Motorized
 - 2) Prevents outside air from entering back into the building when fan is off
 - 3) Balanced for minimal resistance to flow
 - 4) Galvanized frames with prepunched mounting holes
- e. Filters:
 - 1) Mounted in open end racks for easy removal
 - 2) Washable 2 inch aluminum mesh designed to remove contaminants from the air
- f. Finishes:
 - 1) Type: Permatorator
- g. Hood Insulation:
 - 1) Lined with 1 inch fiberglass insulation to prevent condensation and sound levels
- h. Insect Screen:
 - 1) Constructed of fine mesh aluminum
 - 2) Fitted to the top of the throat and prevents entry of insects
 - 3) Coating Type: Permatorator

C. Spun Aluminum Relief Gravity Ventilator - Greenheck Model GRS

- 1. General Description:
 - a. Ventilator is low silhouette for relief applications with natural gravity or negative pressure system
 - b. Selection based on ducted applications
 - c. Intake unit sizes 8 to 48
 - d. Each unit shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number
- 2. Hood:
 - a. Constructed of aluminum
 - b. Internal structure is constructed of galvanized steel
- 3. Birdscreen:
 - a. Constructed of ½ inch Galvanized steel mesh
 - b. Mounted horizontally across the intake area of the hood
- 4. Housing:
 - a. Curb Cap type: No Hinged
 - b. Constructed of aluminum, includes windband and curb cap. Galvanized material is not acceptable
 - c. Windband to be one piece spun aluminum construction and maintain original material thickness throughout the housing.
 - d. Windband to include an integral rolled bead for strength
 - e. Curb cap to have integral deep spun inlet venturi and prepunched mounting holes to ensure correct attachment to roof.
- 5. Options/Accessories:
 - a. Roof Curbs:
 - 1) Type: GPI
 - 2) Mounted onto roof with fan
 - 3) Material: Aluminum

- 4) Insulation thickness: 1 inch
 - 5) Coating Type: None
- b. Dampers:
 - 1) Type: Gravity
 - 2) Prevents outside air from entering back into the building when fan is off
 - 3) Balanced for minimal resistance to flow
 - 4) Galvanized frames with prepunched mounting holes
- c. Finishes:
 - 1) Type: Permatector
- d. Flashing Flange:
 - 1) Constructed of aluminum
 - 2) Pre-punched holes for installation without a roof curb

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with lag screws to roof curb.
- C. Extend ducts to roof exhausters into roof curb.
- D. Install flexible connections where indicated.
- E. Provide sheaves required for final air balance.
- F. Install backdraft dampers on inlet to roof exhausters.
- G. Provide backdraft dampers on outlet from cabinet and ceiling exhausters fans and as indicated.
- H. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fan has been test-run under observation.

END OF SECTION 230860

SECTION 230890 - DUCTWORK SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

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

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.
- 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 230010.
- 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: 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. Seam construction shall be welded, or Pittsburgh.
- C. Stainless Steel Ducts: ASTM A167, Type 304.
- D. Insulated Flexible Ducts:
 - 1. Manufacturers:
 - 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, gauges, 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 prepared for painting.
- F. Exposed round and rectangular metal ductwork shall be field painted in color selected by Architect.
- G. Size shall be as follows:
1. 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
 2. 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
 3. Round Duct – Spiral – Spiral Lock Seam Type (except Double Wall)

<u>Duct Dimension</u>	<u>Steel US Standard Gauge</u>
Up through 14"	26
15" – 26"	24
27" – 36"	22

<u>Fitting Dimension</u>	<u>Steel US Standard Gauge</u>
Up through 14"	22
15" – 26"	22
27" – 50"	20

2.3 MANUFACTURED DUCTWORK AND FITTINGS

- A. Manufacture 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. 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
 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 line. 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.

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.

- C. Exposed round metal ductwork shall be field painted in color selected by Architect.
- D. Provide manufactured round double wall ductwork for all ducts exposed and ducts installed above ceiling clouds. Refer to the architectural reflected ceiling drawings for locations.

2.4 KITCHEN HOOD EXHAUST DUCTWORK

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible and IMC.
- B. Construct of 16-ga carbon steel or 18-ga stainless steel, using continuous external welded joints.

2.5 AIR TURNING DEVICES/EXTRACTORS

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

2.6 BACKDRAFT DAMPERS

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

2.7 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.

2.8 FIRE DAMPERS (FD)

- 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.
- 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.

2.9 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.

2.10 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"x72". 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.

2.11 BRICK VENT (BV)

- A. Frame: Heavy gauge extruded 6063T5 aluminum, 4 in. x 0.125 in. nominal wall thickness.
- B. Blades: Heavy gauge extruded 6063T5 aluminum, 0.125 in. nominal wall thickness, positioned at 45° angles.
- C. Construction: Mechanically fastened.
- D. Insect Screen: 18"X 14"aluminum mesh, inside mount (rear).
- E. Finish: Baked enamel in color selected by the Architect.
- F. Size: 15 5/8 in. W X 7 ¾ in. H
- G. Accessories: Opposed blade damper.

2.12 LOUVERS (L)

- A. Manufacturers:
 - 1. Greenheck
 - 2. Acceptable equal by Construction Specialties, Ruskin
- B. Type: 4" deep with blades on 45° slope heavy channel frame, birdscreen with 2" square mesh for exhaust and 3/4" for intake. Drainable fixed blade mullion type.
- C. Fabrication: 16-ga thick galvanized steel welded assembly, with factory Kynar finish color to be selected by Architect.
- D. Mounting: Furnish with interior screw holes in jambs for installation.

2.13 RECTANGULAR CEILING DIFFUSERS (D)

- A. Manufacturers:
 - 1. Tuttle & Bailey Model RC

- 2. Acceptable equal by Anemostat, Titus, Carnes, Metalaire, Krueger, Price provided specifications are met.
- 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.

2.14 CEILING EXHAUST AND RETURN REGISTERS/GRILLES (R)

- A. Manufacturers:
 - 1. Tuttle & Bailey 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.

2.15 FILTER RETURN GRILLES (R)

- A. Manufacturers:
 - 1. Tuttle & Bailey Model T70DFB
 - 2. Acceptable equal by Anemostat, Titus, Carnes, Metalaire, Krueger, Price provided specifications are met.
- B. Type: Horizontal steel blades on 3/4" centers with blades det at 35°.
- C. Frame: 1-1/4" margin with mitered corners.
- D. Fabrication: 22-ga steel construction. 2" filter frame, quarter turn fasteners with hinge. In lay-in tile ceilings provide 24"x24" modules. Surface mount all others.

- E. Filters: Provide with all return filter grilles. Filters shall be synthetic, wire frame type with an efficiency of MERV 13. Filters shall meet ANSI/UL-900 requirements. Provide filters with antimicrobial treatment.

2.16 SUPPLY REGISTERS (D)

- A. Manufacturers:
 - 1. Tuttle & Bailey, AV54 with horizontal blade adjustment (front) and vertical adjustment (rear)
 - 2. Acceptable equal by Anemostat, Titus, Carnes, Metalaire, Krueger, Price provided specifications are met.
- 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.

2.17 ROUND SUPPLY DIFFUSER (D)

- A. Manufacturers:
 - 1. Tuttle & Bailey P3
 - 2. Acceptable equal by Anemostat, Titus, Carnes, Metalaire, Krueger, Price provided specifications are met.
- B. Type: Round three cone with round inlet, with 2 position cone adjustment to minimize induction.
- C. Fabrication: Steel construction with retainer (safety) cable on all diffusers. Color to match attached exposed duct as selected by the Architect. Provide with round heavy gauge steel damper and be operable from face of diffuser.

2.18 HEAVY DUTY WALL EXHAUST AND RETURN REGISTERS/GRILLES (R)

- A. Manufacturers:
 - 1. Titus & Bailey, Model T115
 - 2. Acceptable equal by Anemostat, Titus, Carnes, Metalaire, Krueger, Price provided specifications are met.
- B. Type: Heavy Duty, steel, single deflection blades, 1/2" minimum depth, 1/2" maximum spacing with 38° fixed bars, horizontal or vertical face with bars in shortest dimension.
- C. Frame: 1-1/4" margin with concealed mounting and gasket.

- D. Fabrication: 14-ga steel bars, with 16-ga steel margin, color to be selected by Architect.
- E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.19 LINEAR SLOT DIFFUSERS

- A. Manufacturers:
 - 1. Tuttle & Bailey, AIR TRAC
 - 2. Acceptable equal by Anemostat, Titus, Carnes, Metalaire, Krueger, Price provided specifications are met.
- B. Diffusers shall be of extruded aluminum construction capable of field adjustment for horizontal or vertical discharge.
- C. Units shall integrate into the ceiling system using margins and/or mounting hardware. Units shall be supported using C01-Hanging Clips.
- D. Exposed flange shall be color as selected by architect. Interior of the diffuser shall be painted black.
- E. The manufacturer shall provide published performance data tested in accordance with the ANSI/ASHRAE Standard 70.

2.20 NEEDLE POINT BIPOLAR IONIZATION (NPBI) - ELECTRONIC AIR CLEANER

- A. Manufacturers:
 - 1. Unit mounting on ductwork: GPS Air; Model DM-2 with optional DM-S round-duct adapter and optional PS2 power supply.
 - 2. Unit mounting on a Blower Fan: GPS Air; Model GPS-FC24-AC or GPS-FC48-AC.
 - 3. Equal provided they meet the basis of design.
- B. Characteristics:
 - 1. Materials: Nonmetallic composite with carbon fiber ion emitters.
 - 2. Provide integral alarm dry contacts, SPST (NO), rated 1.0 A at 250 V ac.
 - 3. Provide inline on-off switch and programmable autocleaning cycle.
 - 4. Temperature Range: Minus 20 to plus 140 deg F.
 - 5. Relative Humidity Range: Zero to 100 percent.
- C. Electric Characteristics:
 - 1. Electrical Listings: UL, cUL.
 - 2. Compliance and Certifications: CARB, CE, FCC Part 18, UL 867, UL 2043, UL 2998.
 - 3. Input Voltage: 24 V dc.
 - 4. Power Consumption: 4 W, operating; 8 W, cleaning.
 - 5. Output Power: 2 kV RMS, plus or minus 10 percent.
 - 6. Total Ion Output: Minimum 400 million ions/cc, measured 1 inch from carbon fiber brushes.
- D. Mounting: Provide rare earth magnets for mounting.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Rectangular ductwork shall be galvanized unless otherwise noted.
- B. Provide aluminum ductwork for dishwasher exhaust system and for shower room branch ductwork.
- C. Provide interior epoxy or coated galvanized round ductwork for Fume Hood Exhaust Systems
- D. Install in accordance with manufacturer's instructions.
- E. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- F. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- H. Use double nuts and lock washers on threaded rod supports.
- I. Connect terminal units to supply ducts with 1' maximum length of flexible duct. Do not use flexible duct to change direction.
- J. Connect diffusers to low pressure ducts with 8' maximum length of flexible duct held in place with strap or clamp. (Concealed areas only.)
- K. Connect flexible ducts to metal ducts with adhesive.
- L. Set plenum doors 6 to 12" above floor. Arrange door swings so that fan static pressure holds door in closed position.
- M. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- N. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- O. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- P. 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"x8" size for hand access, 18"x18" size for shoulder access, and as indicated. Provide 4"x4" for balancing dampers only. Review locations prior to fabrication.

- Q. 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.
- R. Demonstrate re-setting of fire dampers to Owner's representative.
- S. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- T. 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.
- U. 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.
- V. Support duct silencers independent of ductwork.
- W. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- X. Install diffusers to ductwork with airtight connection.
- Y. Paint ductwork visible behind air outlets and inlets matte black.

3.2 DUCT CLEANING (EXISTING DUCTWORK)

- A. Approved Agencies: All bidders must be NADCA and IAQA Certified
- B. The Contractor/Agency shall document all existing ductwork associated with HVAC units being modified/reused/relocated, and provide a set of drawings to the owner complete with ductwork routing, air outlet devices and inspection access locations.
- C. Existing air conditioning duct system being reused, supply and return, (as noted on drawings) shall be thoroughly cleaned. This includes dampers of any type, turning vanes, and any other accessories installed in the duct system.
- D. Do not include existing classroom air conditioning ducts not being renovated (as noted on drawings).
- E. The Contractor shall be responsible for providing access, as necessary to all portions of the duct systems. All access openings shall be closed with metal plates at least 1" larger in all directions than the access opening. The metal plates shall be no less than 20-ga and shall be secured with sheet metal screws and sealed with gasket duct tape. Sufficient access openings shall be furnished to ensure effective working access to all portions of the duct systems.
- F. The Contractor shall furnish all required tools necessary to gain access to the duct system, to close the access openings, wire brushed to clean all portions of the system, high pressure vacuum

cleaner to clean all portions of the system, and all auxiliary equipment such as ladders, scaffolding, extension cords, safety equipment, etc. The high-pressure vacuum cleaner shall include HEPA filter to prevent the transfer of possibly harmful dust from the ducts, etc., to other parts of the building.

- G. The Contractor shall provide cover with drop cloths for all furniture and machinery located under or adjacent to work area. At the completion of work in this area, the Contractor shall clean up all debris and dust resulting from his work.
- H. The Contractor shall provide the following certifications, license information, etc.:
 - 1. How long has the contractor been in the commercial HVAC system cleaning business?
 - 2. Provide evidence of current Worker's Compensation and General Liability Insurance coverage.
 - 3. Provide copies of the proper Licenses that are required by Pennsylvania.
 - 4. Provide 3 to 5 references with contact phone numbers for projects of similar size and scope of work which they provided service in the last year.
 - 5. Provide written safety, respiratory, and confined space programs in addition to OSHA compliance reports.
 - 6. Provide means to conduct a visual inspection at any time during the cleaning.
 - 7. If contracting company is sub-contracting work out, provide certifications, licenses, etc., for the sub-contractor as well.
 - 8. Contractor shall assign an Air Systems Cleaning Specialist (ASCS) to the project that will be responsible for the complete project.
 - 9. If there is any remediation of mold or other biological contamination, the Contractor shall have a Ventilation System Mold Remediator. (VSMR) on staff.

3.3 CLEANING (NEW DUCTWORK)

- A. New ductwork shall be sealed, covered, and protected from dust and dirt. Contractor shall install clean ductwork, if dust or dirt is allowed into the system then clean duct system with 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.

3.4 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.

3.5 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"x3/16" angle iron and 1/2" threaded rod - 6' centers.

3.6 DUCT ACCESS DOORS AND FIRE AND SMOKE 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.

3.7 NPBI INSTALLATION

- A. Mount and wire devices at locations indicated on Drawings.

- B. Install devices in accordance with manufacturer's written instructions.
- C. Electrical Requirements: Wiring, conduit, and junction boxes.
 - 1. Install within housing plenums in accordance with NFPA 70.
- D. Position each electronic air cleaner unit with clearance for service and maintenance. Anchor electronic air cleaners to substrate.
- E. NPBI Systems:
 - 1. Prior to Owner acceptance, remove damaged or failed components from site and replace with new components at no cost additional cost.
 - 2. Protect components from dust and damage from time of installation until Owner acceptance.
- F. Do not operate fan system until electronic air cleaners and associated prefilters and final filters are in place.
 - 1. Replace temporary filters used during construction and testing with new, clean filters.
- G. Operate electronic air cleaners for 24 hours as part of startup before ventilations systems are put into operation.
- H. Coordinate electronic air cleaner and associated prefilter and final filter installations with duct and air-handling-unit installations.
- I. Product: GPS-DM2, NPBI Auto-Cleaning Air Ionization System.
 - 1. Install air ionization system in supply duct downstream of VAV or other zone control units.
 - 2. Do not install air ionization system upstream from unit filter.
- J. Product: GPS-FC48-AC, GPS-FC24-AC, NPBI Auto-Cleaning Air Ionization System.
 - 1. Install air ionization system at blower inlet, on side opposite blower motor
 - 2. Do not install air ionization system upstream from unit filter.
- K. Mechanical Installation:
 - 1. Install ionization emitter perpendicular to air flow direction. Mount so ion emitters are exposed to, and perpendicular to airstream. Mount ion emitters so airflow passes between them.
- L.
- M. Manufacturer's Inspection and Training Services: Furnish services of manufacturer authorized representative to verify correct installation and perform training of Owner's staff.
- N. STARTUP, COMMISSIONING, AND TRAINING
 - 1. Manufacturer's Startup Services: Provide startup supervision and training of Owner's personnel in the proper operation and maintenance of equipment.
 - 2. Commissioning Agent: Use Alpha Labs Air Ion Counter's Model "AIC2" or "AIC3-Pro" and confirm, on installed units, that ion output meets value listed on product data sheet when both polarities are measured and added together.
 - 3. Measurement: One inch (25 mm) from electrode without airflow.

4. For Each Installation: Randomly select and test minimum 10 percent of installed units to confirm compliance and Submit test report.
5. Training: Train Owner's personnel on use and replacement of NPBI air ionization system or NPBI components.

O. .

3.8 KITCHEN HOOD EXHAUST DUCTWORK

- A. Kitchen hood exhaust ductwork shall be installed as shown on the drawings. Installation of this system shall be in accordance with NFPA 96. The following excerpts from the code are included as reference only. Refer to NFPA 96 code for the complete requirements for this system.
 1. Listed grease ducts shall be installed in accordance with the terms of the listing and the manufacturer's instructions.
 2. Other grease ducts shall comply with the following requirements:
 - a. Ducts shall be constructed of and supported by carbon steel not less than 0.054" (#16 MSG) or stainless steel not less than 0.043" (18MSG) in thickness.
 - b. All seams and joints shall have a liquid tight continuous weld.
 3. All ducts shall be installed without forming dips or traps which might collect residues.
 4. A residue trap shall be provided at the base of each vertical riser with provisions for cleanout.
 5. The opening large enough to permit cleaning shall be provided at each change of direction of the duct and at louver for purposes of inspection and cleaning. Such openings shall conform to the following:
 - a. Opening shall be at the sides of the duct.
 - b. In horizontal sections the lower edge of the opening shall be not less than 12" from the bottom of the duct.
 - c. Covers shall be constructed of the same material and thickness as the duct and shall be grease tight when in place.
 6. Dampers shall not be installed in ducts or duct systems except when specifically listed for such use or required as part of a listed or approved device or system.

END OF SECTION 230890

SECTION 230900 - ATC SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Johnson Controls HVAC Control Equipment & Wiring
- B. Johnson Controls Metasys Building Management System
- C. Software including Graphics Package
- D. Building Systems Interface
- E. Sequence of Operation

1.2 SCOPE OF WORK

- A. The system shall extend the existing campus Branch Metasys BMS to implement a single Graphical User Interface (GUI) as the single-seat solution for HVAC Control and electrical systems monitoring and control as specified herein. Please contact Mike Turriziani for Branch Metasys scope of work, Mike.turriziani@jci.com.
- B. Provide occupied/unoccupied/warm-up zone control for zones as follows. Provide with four (4) Optimizer Zones.
 - 1. Cafeteria
 - 2. Kitchen
 - 3. Gymnasium
 - 4. Lobby and Public Toilets, Corridors, Etc.
 - 5. Admin. Office, Health Office, Guidance Office
 - 6. Media Center/ Library
 - 7. Classrooms Area A
 - 8. Classrooms Area B
 - 9. Classrooms Area C
 - 10. Classrooms Area D
 - 11. Classrooms Area E
- C. Furnish and install a complete electronic DDC system of automatic control for controlling all new HVAC equipment throughout the building.
- D. Interface the Lighting Control System as described in Section 23 09 60 for control of the specified lighting zones.
- E. Provide interface to electric meter (furnished and installed by the Electrical Contractor).

- F. Provide interface to the existing campus wide Metasys System for monitoring of PJM and local distribution company(s) current and forecasted loads; and for implementing automated curtailment strategies.
- G. DDC System shall control Day/Night/Auto time schedule and optimizer control for all zones.
- H. Through the HVAC Control System, provide the necessary points and associated sensors, relays, valves, wiring, programming, etc. to accomplish to Sequence of Operations as specified herein.
- I. New DDC Control Panel shall be connected, by means of Ethernet connection to a personal computer (provided by the Contractor) located as directed by the Owner.
- J. Provide full graphics package as part of software.
- K. Power Monitoring:
 - 1. Provide an interface to the KWH and KW demand signals from a digital multimeter provided on the main electric service by the Electrical Contractor.
 - 2. Provide electrical data (kWh and kW) to the Johnson Controls Metasys Server
 - 3. Provide real time graphic displays of power usage including current usage, year-to-date usage, maximum usage, and minimum usage for each category of use.
 - 4. Provide real time and forecasted PJM Grid load.
 - 5. Provide real time and forecasted load for the PPL and Met Ed utilities.
 - 6. Energy usage data shall be accurate to 1% and will be used for LEED validation of the building design.
 - 7. The BAS shall provide all electrical power data to the Owner via a graphic interface and reports.
- L. Generator Monitoring:
 - 1. The BAS system shall display 16 pre-warning and alarm conditions for the standby electric generator.
 - 2. Interface to the generator will be by way of a Modbus connection between the generator control and the BAS.
- M. UPS Power System: Provide UPS power units for the BAS panel to keep systems powered constantly during switchover from normal to emergency power.
- N. The "Scope of Work" to be performed under this Contract shall be used as a guide only and will not be considered as the limit of this contract. Any additional items which are not specifically called for, but which are required by the specification shall be furnished and installed by the contractor without additional cost to the School District.

1.3 QUALIFICATIONS

- A. The Automatic Control System shall be installed complete by competent, trained mechanics regularly employed by the manufacturer of the automatic control equipment. Control manufacturer shall have an established (minimum of 20 years) branch office staffed with installation and service mechanics; factory trained engineers and technicians fully capable of

rendering training, instruction, and engineering assistance; as well as providing routine and emergency service on all system components.

1.4 PRODUCTS NOT FURNISHED UNDER THIS SECTION

- A. Smoke detectors will be furnished and installed by Electrical Contractor who will provide an auxiliary contact for connection by ATC Contractor.

1.5 SUBMITTALS

- A. Submit in accordance with provisions of Section 23 00 10.
- B. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. List of connected data points, including connected control unit and input device.
 - 3. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
 - 4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - 5. Descriptive data and sequence of operation of operating, user, and application software.
 - 6. Minimum requirements for Owner supplied hardware.
- C. Product Data: Provide data for each system component and software module including catalog sheets, specifications, wiring, damper and valve schedule, flow diagram of system.

1.6 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
 - 4. Prohibiting transfer to a third party.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The System shall be an extension of the district's existing Metasys BMS as furnished and installed by Johnson Controls, Inc.
 - 1. Johnson Controls Inc. – Contact: Mike Turriziani, (610) 247-6062, mike.turriziani@jci.com

2.2 GENERAL

- A. The Building Automation System shall include but not be limited to the following components.

1. The Operator Interface shall consist of hardware and software that allows full user monitoring and adjustment of system parameters.
 2. System Application Controllers shall manage the Energy and Building Management capabilities of the automation system as well as facilitate remote communications and central monitoring.
 3. Application Specific Controllers shall provide distributed, pre-engineered control, specific to the mechanical equipment specified.
 4. Custom Application Controllers with distributed custom programming capability shall provide control for nonstandard control sequences.
 5. The Data Communications capability shall allow data to be shared between the various controllers in the architecture.
 6. The system software shall include system software for global application functions, application software for distributed controllers, and operator interface software.
 7. End devices such as sensors, actuators, dampers, valves, and relays.
- B. The failure of any single component shall not interrupt the control strategies of other operational devices. System expansion shall be through the addition of end devices, controllers, and other devices described in this specification.
- C. All system components are to be designed and built to be fault tolerant.
1. Provide satisfactory operation without damage at 110% above and 85% below rated voltage and at +3 hertz variation in line frequency.
 2. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be a.c. coupled or equivalent so that any single device failure will not disrupt or halt bus communication.

2.3 ACCEPTABLE MANUFACTURERS

- A. Type and manufacturers: Fully integrated Building Management System (BMS) incorporating Type and manufacturers: Fully integrated Building Management System (BMS) incorporating Network Central Processors (NCP), Energy Management Monitoring and Control. All control components shall be standard products of the manufacturer.
- B. The system shall be provided and installed by Johnson Controls, Inc.

2.4 SPECIFICATION NOMENCLATURE

- | | | |
|----|---------|---|
| A. | ASC | Application Specific Controller |
| B. | BC | Building Controller |
| C. | CAC | Custom Application Controller |
| D. | CSMA/CD | Carrier Sense Multiple Access/ Collision Detect |
| E. | FMCS | Facility Management Control System |

F.	FTT	Free Topology Transceivers
G.	GP	Graphical Programmer
H.	GUI	Graphical User Interface
I.	ISO	International Standards Organization
J.	LAN	Local Area Network
K.	LCD	Liquid Crystal Display
L.	UTP	Unshielded Twisted Pair
M.	WAN	Wide Area Network

2.5 MATERIALS

- A. All products used in this project installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of [2] years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's Representative in writing. Spare parts shall be available for at least 5 years after completion of this contract.

2.6 COMMUNICATION

- A. Control system provided for this project shall consist of a peer-to-peer networked, stand-alone, distributed system. The FMCS (Facility Management Control System) requires the incorporation of BACnet Technologies using specific conformance to the latest BACnet guidelines in all unitary, terminal units and other DDC devices.
- B. BACnet communications protocol shall be used on the Primary Control communication network between FMCS controllers and other BACnet devices to assure interoperability between all devices within the network.
- C. The FMCS shall support the direct integration of standard and non-standard communicating systems. At a minimum, the FMCS shall deliver connectivity at the BACnet, IP, and GUI levels through standard offerings. The FMCS shall offer as a standard available solution, a minimum of 300 individual communicating interfaces to 3rd party products.
- D. The FMCS shall provide compliance with the ANSI/ASHRAE standard 135-1995 for interoperability.
- E. The FMCS shall provide a high-speed Enterprise Network Interface that shall plug directly into the BC (Building Controllers) which supports one of the following types of communication standards between BCs:
 - 1. Ethernet:
 - a. The Network Interface shall employ Carrier Sense Multiple Access/Collision Detect (CSMA/CD) contention type protocol, which adheres to the industry standard format IEEE 802.3. The content of messages shall be the manufacturer's standard. The

Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3 compliant Ethernet Networks.

- b. The Network Interface shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 10Base2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors), 10Base T (Twisted-Pair RJ-45 terminated UTP cabling).

2. BACnet:

- a. The ability to support bi-directional access to remote BCs shall be supported by a single point of connection. The ability to monitor and edit system data shall be provided via the BC remote communication connection. Connection via the GUI, the GP as well as a standard VT-100 terminal interface shall be provided. Support for solicited as well as unsolicited communications is a requirement.
- b. Enterprise Level Communication Network (ELCN) shall consist of high-speed BACnet/IP Local Area Network (LAN) and/or Wide Area Network (WAN) to host Operators Workstations (B-OWS), Building Controllers (B-BC), Building Level Communication Networks (BLCN) and Web-Enabled remote connectivity
- c. Building Level Communication Network (BLCN) shall consist of a BACnet internetwork to host field level DDC Controllers.
- d. B-BC's shall automatically route BACnet communications to all configured available BACnet networks.
- e. B-OWS and B-BC's shall be fully IT-compatible devices that communicate directly on a TCP/IP Local Area Network (LAN).
 - 1) LAN shall be 10/100Mbps TCP/IP with the following minimum requirements:
 - a) Cable: 10 base-T, UTP-8-wire, category 5e or greater
 - b) Minimum throughput: 10Mbps with the ability to increase to 100Mbps
 - 2) Enterprise Level Communication Network (ELCN) shall provide communication between BBC's, B-OWS, remote B-OWS and Web Server using a B/IP LAN backbone.
 - 3) B-BC's shall connect directly to the LAN and communicate using B/IP without a TCP/IP Gateway or network server
 - 4) Owner shall be responsible for providing TCP/IP networking scheme, addressing, &c. It shall be the responsibility of the BAS Contractor to coordinate implementation of the BAS on the Owner's LAN without disruption.
- f. BAS Manufacturer must natively support the following BACnet data links as defined in the ANSI/ASHRAE Standard 135-2008, BACnet:
 - 1) Point-to-Point (PTP)
 - 2) Master Slave/Token Passing (MS/TP)
 - 3) Ethernet (ISO 8802-3)
 - 4) BACnet IP (B/IP)
- g. Field sensors and control devices shall connect to peer-to-peer, fully programmable B-BC, B-AAC & B-ASC as required to achieve the point monitoring and Sequence of Control as specified herein. All devices are to be monitored by a B-OWS. Final control devices are to be electronic.
- h. There shall be no power wiring, in excess of 30 Vac rms voltage, run in conduit with communications trunk wiring. In cases where power or signal wiring is run in conduit with trunk wiring, all communications trunk wiring and power wiring shall be run using separate twisted pairs, 22-ga, (Cat 4).

- i. The FMCS shall support the direct integration of standard and non-standard communicating systems. At a minimum, the FMCS shall deliver connectivity at the BACnet, Lon, IP, and GUI levels through standard offerings. The FMCS shall offer as a standard available solution, a minimum of 300 individual communicating interfaces to 3rd party products. The FMCS shall provide a standard available kit for development of additional interfaces by others, in addition to the FMCS manufacturer.
- j. The FMCS shall provide compliance with the ANSI/ASHRAE Standard 135-1995 for interoperability.

2.7 OPERATING INTERFACE (GRAPHICAL USER INTERFACE)

A. System Software (GUI):

- 1. Operating System. FMCS shall operate under Windows environment.
- 2. System Graphics: The operator workstation software shall be graphically oriented. The system shall allow display of multiple graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while online. An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the point.
- 3. Custom Graphics: Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as AI, TGA, PCX, JPEG, and BMP. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Designer, AutoCAD or Visio.
- 4. Graphics Library: Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, and variable air volume terminals. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
- 5. Graphic Tools: Graphic applications shall support Active X controls and use them in any application window. Active X controls shall be used to handle control events, call control methods, and set and get control properties from quick scripts

B. System Applications: The operator workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation:

- 1. System Database Save and Restore: The workstation shall store on the hard disk a copy of the current database of each building controller. This database shall be updated whenever a change is made in any system panel. In the event of a database loss in a building management panel, the workstation shall be able to restore the database for that panel.
- 2. Manual Database Save and Restore: A system operator with the proper password clearance shall be able to save the database from any system panel. The operator also shall be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

3. System Configuration: The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection.
4. On-Line Help: Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
5. Security: Each operator shall be required to log on to the system with a username and password in order to view, edit, add, or delete data. System access level shall be selectable up to 9999 levels, for each operator. The system administrator shall have the ability to set passwords and access levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object. Each operator shall automatically be logged off the system if no keyboard or mouse activity is detected. This adjustable auto logoff time shall be set per operator password. All system security data shall be stored in an encrypted format.
6. System Diagnostics: The system shall automatically monitor the operation of all associated workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
7. Alarm Processing: Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure multiple alarm limits, alarm limit differentials, states, alarm deviation dead bands and reactions for each object in the system.
8. Binary Alarms: Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
9. Analog Alarms: Each analog object shall have both high/low warning and alarm limits. Limits shall be capable of a fixed or floating setting. Alarming must be able to be automatically and manually disabled.
10. Alarm Reactions: The operator shall be able to determine (by object) what if any actions are to be taken during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day. An object in alarm that has not been acknowledged within an operator-specified time period shall be moved to a higher level of priority. The actions for that level will then be followed.
11. Trend Logs: The operator shall be able to define a custom trend log for any data point/object in the system. This definition shall include interval, start time, and stop time. Trend data shall be sampled and stored on the Building Controller panel and be archivable on the hard disk and be retrievable for use in spreadsheets and standard database programs.
12. Historical Trends: The operator shall be able to define a custom historical trend chart for up to eight pens (any data point/object in the system). Historical trend shall be updated when they are instructed to do so, either through the execution of a quick Script or an action by the operator. The operator shall have complete flexibility in designing the interface for the trend. Operator shall be able to create buttons to zoom in and out between the scooters or to data, such as the maximum to minimum value. Average and standard deviation shall be displayed for a complete chart or for the area between scooters. Historical trends shall also be scrolled by any amount of time. Custom scales shall be created and linked to the data fields to display the minimum and maximum engineering units.

13. Alarm and Event Log: The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.
14. Object and Property Status and Control: Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. The status shall be available by menu, on graphics, or through custom programs.
15. Clock Synchronization: The real-time clocks in all building control panels and workstations shall be synchronized on command of an operator. The system also shall be able to automatically synchronize all system clocks daily from any operator-designated device in the system. The system shall automatically adjust for daylight savings and standard time, if applicable.
16. Reports and Logs: Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archivable on the hard disk for historical reporting. Provide the ability for the operator to obtain real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the Administration Building PC hard disk in a format that is readily accessible by other standard software applications, including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer and shall be set to be printed either on operator command or at a specific time each day.
17. Standard Reports: The following standard system reports shall be provided for this project. Provide ability for the owner to readily customize these reports for this project for all applicable monitored devices and points specified.
 - a. All Point: All system (or sub-system) points and their current value.
 - b. Alarm Summary: All current alarms (except those in alarm lockout).
 - c. Disabled Points: All points that are disabled.
 - d. Alarm Lockout points: All points in alarm lockout (whether manual or automatic).
 - e. Alarm Lockout points in alarm: All points in alarm lockout that are currently in alarm.
 - f. Logs:
 - 1) Alarm History
 - 2) System Messages
 - 3) System Events
 - 4) Trends
18. Custom Reports: Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. These reports shall be time and date stamped and shall contain a report title and the name of the facility.
19. Workstation Applications Editors: The PC workstation shall support editing of all system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at the controller panels.
20. Controller: Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
21. Scheduling: An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and month. This shall consist of a monthly calendar for each schedule. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a

schedule. The start and stop times for each object shall be adjustable from this master schedule. Schedules shall be easy to copy to other objects and/or dates.

22. Custom Application Programming: Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:
- a. The programming language shall be graphically based using function blocks. Function blocks shall directly provide the functions listed below, and system shall allow user to create custom or compound function blocks. Alternatively, the language can be English language oriented, based on the syntax of BASIC, FORTRAN, C, or PASCAL, and allow for free-form programming (i.e., not column-oriented or “fill in the blanks”).
 - b. A full-screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate word processing features such as cut/paste and find/replace.
 - c. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
 - d. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and or results. The debugger also shall provide error messages for syntax and execution errors.
 - e. The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - f. The programming language shall support floating point arithmetic using the following operators: +, -, /, x, square root, and x-to-the-y-power. The following mathematical functions also shall be provided: natural log, log, trigonometric functions (sine, cosine, etc.), absolute value, and minimum/maximum value from a list of values.
 - g. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/THEN comparisons, calculations, etc.
 - h. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.
 - i. The programming language shall have predefined variables representing the status and results of the System Software, and shall be able to enable, disable, and change the set points of the System Software described below.

2.8 SYSTEM APPLICATION SOFTWARE

- A. Furnish the following applications software for building and energy management. All software applications shall reside and operate in the system controllers. Editing of applications shall occur at the operator workstation.
- B. System Security:
 - 1. User access shall be secured using individual security passwords and usernames.
 - 2. Passwords associated with access level shall restrict the user to the objects, applications, and system functions as assigned by the system manager/ administrator.
 - 3. User Log On/ Log Off attempts shall be recorded.
 - 4. The system shall protect itself from unauthorized use by automatically logging off after a time delay following no activity. The delay time shall be user definable.
 - 5. Audit trails shall be created that tie each user to all alarms and events during the time they are logged on to the system.
- C. Scheduling: Provide the capability to schedule each object or group of objects in the system. Each schedule shall consist of the following:
 - 1. Weekly Schedule: Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to adjust the start and stop times for each member.
 - 2. Exception Schedules: Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
 - 3. Holiday Schedules: Provide the capability for the operator to define up to [99] special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
- D. System Coordination: Provide a standard application for the proper coordination of equipment. This application shall provide the operator with a method of grouping together equipment based on function and location. This group may then be used for scheduling and other applications.
- E. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display graphics.
- F. Remote Communication: The system shall have the ability to phone modem dial out or web access notify in the event of an alarm. Receivers shall include ASCII devices, pagers, fax machines, cell phones or computer stations.
- G. Maintenance Management: The system shall monitor equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits.
- H. Sequencing: Provide application software to properly sequence the start and stop of chillers, boilers, and pumps to minimize energy usage in the facility.

- I. PID Control: A self-tuning PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-wind-up shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point, and PID gains shall be user-selectable.
- J. Staggered Start: This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user-selectable.
- K. Energy Calculations: Provide software to allow instantaneous power (e.g., kW) or flow rates (e.g., L/s [GPM]) to be accumulated and converted to energy usage data. Provide an algorithm that calculates a sliding-window kW demand value.
- L. Anti-Short Cycling: All binary output points shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.
- M. On/Off Control with Differential: Provide an algorithm that allows a binary output to be cycled based on a controlled variable and set point. The algorithm shall be direct-acting or reverse-acting and incorporate an adjustable differential.
- N. Automatic Alarm Lockout:
 - 1. This package will enable alarms generated by analog or digital inputs, or calculated points, to be locked out when equipment they are associated with is not operating for any reason. Either ON or OFF status condition may be designated as the auto alarm lockout status.
 - 2. Enabled analog and digital inputs shall continue to be scanned, and the current values shall appear on all relevant logs together with an identification of all inputs having the auto-lockout feature.
 - 3. Provide the means for an override of auto-lockout on operator-specified inputs, whether or not the associated system is operational.
 - 4. Upon startup of a system the auto-lockout feature for points on that system shall be automatically removed from that system after an operator-adjustable period of time. The reverse also shall act automatically on the shutdown of the system.
 - 5. Provide a summary log available on demand, on a point/system/building/ total basis.
 - 6. Authorized operators shall be able to add and delete points having the auto-lockout feature and to change the lockout time delay following the startup of systems.
 - 7. The actions of the automatic alarm lockout program shall not cancel existing point alarm conditions.
- O. Calculated Point:
 - 1. Provide a package that will create an on-line pseudo-point as a result of a series of calculations.
 - 2. The calculations may use operator-entered constants, values of other points in the system, or values of other calculated points as variables in the equations.
 - 3. Provide the means for the calculated points to be used in loops for control purposes.
 - 4. Provide the means for points to be created on-line by an authorized operator and formatted into the system for summary purposes (e.g., power factor or equipment efficiencies).

5. Provide the means for totalization of values as part of this package (e.g., energy consumption or flows).
 6. The frequency of the calculation is to be operator-assignable. The default will be the program cycle time.
 7. Provide the means for alarming calculated points, as any other point.
 8. Provide a package to calculate the following psychometric properties of air, when the values of any two are known, corrected for location altitude:
 - a. Dry bulb temperature
 - b. Wet bulb temperature
 - c. Dew point temperature
 - d. Relative humidity
 - e. Enthalpy
- P. Run-Time Totalization:
1. Provide monitoring and totalization of the run-times for all digital status inputs.
 2. Totalization shall be selectable on a per-point basis, for either open or closed condition of the status input.
 3. A high run-time alarm shall be assigned, if required.
 4. Run-times can be reset by an operator having the necessary access level. The date on which the value was reset shall be logged.
 5. Run-times shall be totalized up to 9999 hours before resetting to zero. Automatic resetting to zero shall generate a suitable message.
 6. The maximum scan frequency for run-time will be 6 minutes.
- Q. Optimum START/STOP:
1. Optimum START/STOP programs shall be applied to the central plant equipment and for each air handling unit.
 2. This package shall continuously monitor all of the space temperature transducers served by a respective air handling unit and the outside air temperature for each system specified to be under optimized START/STOP control. The control algorithm shall start the system at the latest possible moment in order to warm up the space to the required temperature (or to cool the space down to the required temperature) prior to scheduled occupancy. When multiple space sensors are associated with a unit, the space temperature sensor that has the largest deviation from set point (heating or cooling) shall be used to determine the optimal START/STOP times for that AHU. When an appropriate number of air handling units are operating in the occupied mode, the central heating/cooling equipment shall be started to maintain building conditions.
 3. This package shall shut the system down for a maximum of one hour (operator-adjustable) early if the space temperature and outside air temperature indicate that the building flywheel effect will maintain the space temperature within acceptable limits until the scheduled unoccupied period.
 4. The initial setup of this package shall be based on empirical, or theoretical, calculations based on the building's construction, orientation, and mass. The package shall be structured such that job-site tuning may be done by simple keyboard entry of one multiplier to the empirical formula, or it shall be adaptive.

2.9 BUILDING CONTROLLERS

- A. General: Provide an adequate number of Metasys Building Controllers to achieve monitoring and control of all data points specified in the I/O summary and all necessary devices to satisfy the sequence of operation for all mechanical systems shown on the plans. Each of these controllers shall meet the following requirements.
1. The Building Automation System shall be composed of one or more independent, standalone, microprocessor-based Building Controllers to manage the global strategies described in the System Software section.
 2. The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 3. Data shall be shared between networked Building Controllers.
 4. The operating system of the Building Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 5. Controllers that perform scheduling shall have a battery backed real-time clock.
 6. The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Generate an alarm notification.
- B. Communication:
1. See Section 2.6 F2
 2. The controller shall provide a minimum of two service communication ports for the connection of serial devices such as the GP (graphical programmer), GUI (Graphical User Interface), modems, printers etc. Connection of a service device, to a service port, shall not cause the controller to lose communication with its peers or other networked device controllers. The controllers shall be able to route alarms, trends, and reports to any serial device connected to the network.
 3. The controllers shall be capable of dialing out to a minimum of 10 remote locations for annunciation of alarms. These alarms shall include the time, date, and alarm condition, in addition to a user defined detailed action message.
- C. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -40°C to 60°C [-40°F to 140°F].
 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 55°C [32°F to 122°F].
- D. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field- removable, modular terminal strips C or to a termination card connected by a ribbon cable.
- E. Memory. The Building Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

- F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m [3 ft].

2.10 CUSTOM APPLICATION CONTROLLERS

- A. General: Provide an adequate number of Metasys System Custom Application Controllers to achieve the performance specified above. CAC's shall be provided for Air Handling Units, Boiler Plant, Chiller Plant and other applications as shown on drawings and shall have published Bacnet application source code, device resource files and external interface definitions. Each of these controllers shall meet the following requirements.
 - 1. The Custom Application Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 - 2. Data shall be shared between networked Custom Application Controllers.
 - 3. The operating system of the Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 - 4. Controllers that perform scheduling shall have a battery backed real-time clock.
 - 5. The Custom Application Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Generate an alarm notification.
- B. Communication:
 - 1. See Section 2.6 F2
 - 2. The controller shall provide a minimum of one service communication port for the connection of serial devices such as the GP (graphical programmer). Connection of a service device to a service port, shall not cause the controller to lose communication with its peers or other networked device controllers.
- C. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -40°C to 60°C [-40°F to 140°F] and 5 to 95% RH, non-condensing.
 - 2. Controllers used in conditioned ambient space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 55°C [32°F to 122°F] and 5 to 95% RH, non-condensing.
- D. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips C or to a termination card connected by a ribbon cable.
- E. Memory: The Custom Application Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- F. Immunity to power and noise: Controller shall be able to operate at 90 to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m [3 ft].

2.11 APPLICATION SPECIFIC CONTROLLERS (ASC)

- A. General: Controls shall be microprocessor based Interoperable BACnet Controllers (ASC), bearing the applicable BACnet interoperability logo on each product delivered. These controllers shall be Metasys CGM/CGE line. ASCs shall be provided for VAV Terminal Boxes and other applications as shown on the drawings and shall contain the appropriate BACnet profile. ASCs shall be based on the Echelon Neuron 3150 microprocessor working from software program memory which is physically located in the ASC. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
 - 1. To simplify controls and mechanical service troubleshooting, the ASC shall be mounted directly in the control compartment of the unitary system. The ASC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL94-5V. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment.
 - 2. A Secondary Control Network may be used at the supplier's option for the ASC and intelligent actuators and sensors. ASC shall reside directly on a peer to peer network utilizing BACnet conformance level 3 configurations. Physical media configuration shall be provided to support the protocol utilized.
 - 3. The ASCs shall be fully supported and communicate with any and all GUI(s) on the bus.
- B. ASC Sensor: The ASC Sensor shall connect directly to the ASC and shall not utilize any of the I/O points of the controller. These shall be Metasys NS Sensors. The ASC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The ASC Sensor shall provide a communications jack for connection to the BACnet communication trunk to which the ASC controller is connected. The ASC Sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the Graphical Programming tool.
 - 1. The ASC Sensor shall be supplied in the following variations:
 - a. Tamper-resistant (no display)
 - b. Tamper-resistant with tenant override
 - c. Basic user functions (LCD display and setpoint adjustment and tenant override)
 - d. Full user functions (LCD display and network-variable access and tenant override)
 - e. ASHRAE 95 compliance (LCD display and sub-base functionality)
 - f. The ASC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering. The ASC Sensor shall allow for the customization of the color on the esthetic covering as a standard offering. User interface with the ASC Sensor shall be provided as a configurable function by the FMCS and shall offer password protection for access to network variable editing. Multiple network variables shall be accessible and editable by the ASC Sensor. Icons shall be utilized to represent sensor and controller function status, affording independence from a single language for use interface.
- C. ASC Functionality: The ASC shall provide a 40 to 140°F ambient operating temperature and 5 to 95% RH, non-condensing humidity range. The ASC shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of any of the ASC electronics. ASC devices that require the electronics to be present at the time of wiring, will require an additional controller to be provided for every 10 devices on the drawings, to allow for the pre-configuration and storing for service purposes.

1. All input/output signals shall be directly hardwired to the ASC. For all non-VAV terminal applications, a minimum of 2 input points of the ASC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If universal points are not available, a minimum of 2 input points (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the ASC shall be of the relay and universal analog form. All digital outputs shall be relay type. ASC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches, or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool (GP) or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ASC or shall be available as I/O points for other controllers throughout the network.
 2. All ASCs shall be fully application programmable and shall at all times maintain their Bacnet certification. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the ASC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
 3. The ASC shall be provided with the ability to interface with the Graphical Programming tool. The interface port shall be provided at the wall sensor or within the ASC equipment, as specified on the plans. The interface port shall allow the GP to have full functionality as described in GP section of this specification. Through the connected controller all ASC and CAC devices on the communication bus shall be accessible by the Graphical Programming tool.
- D. ASC B VAV Controller Functionality: Controls shall be microprocessor-based Pressure Independent Variable Air Volume Digital Controllers, as shown in the drawings. The VAV ASC shall be a single integrated package consisting of a microprocessor, power supply, damper actuator, differential pressure transducer, field terminations, and application software. An alternate model shall be offered that allows for direct connectivity to an external actuator for those applications that employ a non-butterfly style damper configuration. All input/output signals shall be directly hardwired to the VAV ASC controller. The internal actuator shall employ a manual override that allows for powered or non-powered adjustment of the damper position. In all cases, the controller shall automatically resume proper operation following the return of power to, or control by the ASC. Programming, configuring and/or troubleshooting of input/output signals shall be easily executed through the ASC sensor or GP tool connected at the wall sensor location.
1. The VAV ASC control algorithms shall be designed to limit the frequency of damper repositioning, to assure a minimum 10-year life from all components. The VAV ASC shall provide internal differential pressure transducer for pressure in dependent applications with an accuracy of 5%. Flows through transducers requiring filter maintenance are not acceptable. The VAV ASC shall provide zone control accuracy equal to or better than $\pm 1^{\circ}\text{F}$. Systems providing control accuracy's greater than $\pm 1^{\circ}\text{F}$ are not acceptable. With the submittal package, contractor shall provide performance data that verifies control accuracy of the VAV ASC.
 2. All input/output signals shall be directly hardwired to the VAV ASC. A minimum of one input point of the VAV ASC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If a universal point is not available, a minimum of one input point (each) of the dry contact,

resistive and analog voltage/current types must be provided on every controller. The outputs of the ASC shall be of the relay and universal analog form. All digital outputs shall be relay type. ASC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches, or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ASC or shall be available as I/O points for other controllers throughout the network.

3. The FMCS contractor shall provide VAV ASC to the VAV box manufacturer, for factory mounting. The VAV terminal unit supplier shall include in its price all costs for mounting of VAV ASC controller, connection of actuator to damper shaft, wiring of device power, wiring of VAV ASC to fan (fan powered terminal) and wiring to electric reheat coils or reheat valve actuator as specified on drawing.
4. The VAV terminal manufacturer shall provide a multi-point, averaging, differential pressure sensor mounted on the inlet to each VAV box. The VAV terminal unit manufacturer shall supply a line to low voltage transformer, of sufficient capacity, to power the VAV ASC plus all reheat valves and/or contactors and fan circuits associated with the VAV terminal and actuator assemblies. The FMCS contractor shall provide all reheat control valves to the mechanical contractor for mounting and piping. The FMCS contractor shall provide and install all wiring between the valve and VAV ASC controller and between the room sensor and the VAV ASC controller.

2.12 INPUT/OUTPUT INTERFACE

- A. Hardwired inputs and outputs may tie into the system through Building, Custom, or Application Specific Controllers.
- B. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller. Inputs and outputs shall be arranged on interchangeable modules or circuit boards to allow the replacement of a damaged module or board without replacing the entire controller.
- C. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
- D. Pulse accumulation input points. This type of point shall conform to all the requirements of binary input points and accept up to 10 pulses per second for pulse accumulation.
- E. Analog inputs shall allow the monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistors, RTD). Analog inputs shall be compatible with and field-configurable to commonly available sensing devices. To prevent thermal loading, RTDs and thermistors shall be scanned rather than have continuous power applied.

- F. Inputs shall be electrically isolated from their associated field points.
- G. Readings of any analog input point shall be repeatable within 0.1% of range; drift of readings shall be less than 0.2% of range per year. (see accuracy table)
- H. Binary outputs shall provide for ON/OFF operation, or a pulsed low- voltage signal for pulse width modulation control. Outputs shall be selectable for either normally open or normally closed operation.
- I. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.
- J. System Point Capacity: The system size shall be expandable to at least [2] times the number of input/output points required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.13 POWER SUPPLIES AND LINE FILTERING

- A. Control transformers shall be UL and CSA Listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service per NEC requirements.
 - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0-% line and load combined with 100 microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150% current overload for at least 3 seconds without trip-out or failure.
 - a. Unit shall operate between 0°C and 50°C [32°F and 120°F]. EM/RF shall meet FCC Class B.
 - b. Line voltage units shall be UL Recognized and CSA or ETL Approved.
 - c. Acceptable manufacturers: Schneider Electric Building Systems transformers ASP8301 through ASP8311 or approved equal.
- B. Power Line Filtering:
 - 1. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:
 - a. Dielectric strength of 1,000 volts minimum
 - b. Response time of 10 nanoseconds or less
 - c. Transverse mode noise attenuation of 65 dB or greater
 - d. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.14 INPUT/OUTPUT SENSORS

- A. Temperature:

1. Resistance temperature detectors with resistance tolerance of $\pm 0.1\%$ at 21°C , interchangeability less than $\pm 0.2\%$ C, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air.
2. Measuring current maximum 5 MA with maximum self-heat of $0.017^{\circ}\text{C}/\text{MW}$ in fluids and $0.008^{\circ}\text{C}/\text{MW}$ in fluids and $0.008^{\circ}\text{C}/\text{MW}$ in air.
3. Provide 3 lead wires and shield for input bridge circuit.
4. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements where larger or prone to stratification sensor length 2.5 m or 5 m as required.
5. Insertion elements for liquids shall be with brass socket with minimum insertion length of 2-1/2" (60 mm).
6. Supply room sensors with locking cover.
7. Provide outside air sensors with watertight inlet fitting, shielded from direct rays of sun.
8. Provide thermostats or sensors and CO2 sensors in public areas such as toilets, corridors, vestibules, stairs, gymnasiums, locker rooms, etc with guards. Provide wire guards in gymnasium areas and lockable covers in public spaces.
9. All temperature sensors shall have LCD displays.
10. Room sensors shall allow for warmer/cooler adjustment and override capabilities at the sensor programmed to a specific adjustment bandwidth and time duration. Adjustment bandwidth shall be programmable through the Building Automation System. Sensor shall include a timed override that can be disabled through the Building Automation System. The override shall provide an adjustable time override to bring unit from unoccupied mode to occupied mode but not enable ventilation mode unless commanded to by CO2 or if more than 50% of VAV units are in override.

B. Humidity Sensors:

1. Elements: Accurate within 5% full range with linear output.
2. Room Sensors: With locking cover matching temperature sensors used, span of 10 to 60% relative humidity.
3. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0-100% relative humidity.

C. Equipment Operation Sensors:

1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0-5" wg.
2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
3. Status Inputs where Differential Pressure Sensing is Impractical: Current sensitive relay with current transformers, adjustable and set to 175% of rated motor current.

2.15 AUXILIARY CONTROL DEVICES

A. Dampers:

1. Dampers shall be low leakage or high velocity low leakage as specified in the sequence of operations. All proportional dampers shall be opposed blade type. Two position dampers may be opposed or parallel blade type.
2. Damper frames and blades shall be galvanized steel and a minimum of 16-ga. Blade width shall not exceed 8". Dampers and seals shall be suitable for temperature ranges of -50 to 250°F .

3. Standard Low Leakage Dampers: Standard low leakage dampers shall be provided to conserve energy. Dampers shall be equipped with neoprene edge seals and compressible metal jamb seal. Leakage shall not exceed 10 CFM/Sq. Ft. at 4" W.G. differential.
 4. High Velocity Low Leakage Dampers: Where specifically called out in the specification, low leakage dampers shall be furnished. Field replaceable edge and end seals will be installed along the top, bottom and side of the frame and each blade. Seals and bearings shall be suitable for temperature ranges from -40 to 200°F. Leakage shall not exceed 6 CFM/Sq. Ft. at 4" W.G. Differential.
- B. Damper Operators: Damper operators shall be electronic, spring return, low voltage (24VAC) and shall be properly sized so as to stroke the damper smoothly and efficiently throughout its range. Actuator response shall be linear in response to sensed load.
- C. Control Valves:
1. Valve bodies shall be 2-way normally open or closed, or 3-way mixing as specified. Valve bodies 2" and smaller shall be bronze, screwed type and shall be rated at 250 PSIG. Valve bodies 2-1/2" and larger shall be iron, flanged and rated at 125 PSIG except where otherwise noted.
 2. Valves shall have stainless steel stems and allow for servicing including packing, stem, and disk replacement.
- D. Valve Actuators:
1. Valve actuators shall be electronic, spring return, low voltage (24 VAC) and properly selected for the valve body and service.
 2. Actuators shall be fully proportioning and be spring return for normally open or normally closed operation as called out in the sequence of operations.
- E. Low Limit Thermostats:
1. Safety low limit thermostats shall be vapor pressure type with a 20' minimum element. Element shall respond to the lowest temperature sensed by any 1' section.
 2. Low limit shall be manual reset only.
- F. Safety and Status Switches:
1. Freezestats for each piece of the equipment being protected shall have manual reset and shall shut down the supply fan and alarm the DDC when 1' of its 20' element senses a temperature below its set point. Freezestats shall be of sufficient length to effectively protect the coils entire surface.
 2. Differential air pressure switches shall be utilized at each air handling unit for proof of airflow and for filter status - switch shall be diaphragm operated. Field adjustable set point with 0.05" to 12.0" water column range provide sensing tube and tip and install to provide accurate airflow sensing.
- G. Line Voltage Thermostat shall have a repetitive accuracy of +1% of the operating ranges shown. Switch actuation shall be adjustable over the operating temperature range. The switch shall have a snap action form C contact rated for the application.
- H. Control Relays: Control relay contacts shall be rated for the application, with a minimum of 2 sets, 5-amp rating of Form C contacts enclosed in a dustproof enclosure. Relays shall be rated for a

minimum life of one million operations. Operating time shall be 30 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.

- I. High Limit Thermostats: High limit thermostats shall be manual reset type set at 120°F.

2.16 WIRING

- A. All electrical work performed in the installation of the BAS/ATC system as described in this specification shall be per the National Electrical Code (NEC) and per applicable state and local codes. Where exposed, wiring shall be installed in conduit which shall be run parallel to building lines properly supported and sized at a maximum of 40% fill. In no cases shall field installed conduit smaller than 1/2" trade size be allowed. Where conductors are concealed, cable rated for use in return air plenums shall be used.
- B. For connection between DDC panels, utilize RG62U coaxial cable. For connection from DDC panels to Local Controllers, utilize 3-conductor 18-ga RS 485.
- C. Power for DDC panels shall be connected to nearest Normal/Emergency Electric Panel. Provide transformers as required.

2.17 CONTROLLERS

- A. All controllers shall be electronic except where specifically noted to be electric limit thermostats.
- B. All controllers, except room thermostats and unit low-limit thermostats and electric limit thermostats, shall be panel mounted and shall be of the dual input receiver-controller type utilizing transmitters mounted at the location where the temperature is sensed. Transmitters sensing duct temperatures shall be equipped with 8' averaging elements and transmitters sensing water temperature shall be equipped with stainless-steel or brass separable sockets. All transmitters shall be capable of being re-calibrated in the field, if necessary. For each temperature transmitter, furnish and install one dial type temperature indicator in the local control cabinet and, where specified, in the central control cabinet.

2.18 MISCELLANEOUS INSTALLATION

- A. Installation of control dampers specified under this section will be by the HVAC Contractor.
- B. Control valves and wells for immersion elements shall be furnished by the ATC Contractor and installed by the HVAC Contractor.
- C. Interface of the Lighting Control System shall be in conjunction with the Lighting Control provider. The Lighting Control System provider shall provide on-site technical support for all interface requirements with the Lighting Control System.
- D. Installation of the Electric Meter shall be by the Electrical Contractor.

- E. The system shall not be affected by transient current or radio frequency and this system shall not affect the operation of other electrical or communication equipment within building complex.
- F. Use stainless steel flanges to support element in ducts. In liquids, use separable wells.

2.19 CONTROL PANEL(S)

- A. Provide local panel(s) of unitized cabinet type for each system under automatic control including each air handling unit, chillers, cooling tower(s), water boilers, steam boilers and pumps. Mount relays, switches and controllers with control point adjustment in cabinet and temperature indicators, pilot lights, push buttons, clocks and switches flush on cabinet panel face.
- B. Fabricate panels from 12-ga furniture steel with baked enamel finish and hinged key lock door.
- C. Mount panels adjacent to associated equipment on vibration free walls or free-standing steel angle supports. One cabinet may accommodate more than one system in same room. Provide engraved plastic name plates for instruments and controls inside cabinet and on cabinet face.
- D. All wiring in the panel shall be Type THW insulated conductors, color-coded and extended to numbered terminals in the panel. Complete wiring diagrams indicating terminal connections inside the panel shall be placed in the panel. Each switch and control in the panel shall be labeled. Each switch and thermometer on the face shall be labeled with Bakelite nameplates.

2.20 AIRFLOW MEASURING STATIONS

- A. Furnish and install Airflow Measurement Stations on all supply air, outdoor air and exhaust air systems for Rooftop Units (RTAC).
- B. Measurement Stations shall be Ebtron Gold Series systems or equal with required interface and shall monitor and control fans and dampers via the ATC System.

2.21 LOW TEMPERATURE DETECTION THERMOSTATS

- A. Low temperature detection thermostats with manual resets shall be provided where indicated. The sensing elements shall be not less than 20' long and shall be installed to sense all representative temperatures across the entire duct or unit cross section.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install electrical work in accordance with NEC. Electrical material and installation shall be in accordance with appropriate requirements of Division 16.

- C. Start-up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- D. Provide service engineer to instruct Owners representative in operation of system.
- E. Provide basic operator training on data display, alarm and status descriptions, requesting data, execution of commands, request of logs and graphics design. Include a minimum of 24 hours dedicated instruction time and 10 hours programming time.

PART 4 - SEQUENCE OF CONTROLS

4.1 CONTROL OF BOILERS

- A. The hot water system consists of two boilers, primary/boiler hot water pumps with VFD, and secondary hot water pumps with VFD. Loop differential pressure sensor and is set up as a variable secondary loop. Outside air temperature and humidity are monitored at the sensors OA-T and OA-H and are shared across the Metasys BAS Network.
- B. Boilers shall be controlled to maintain required supply water temperature. Temperature shall be adjustable.
- C. Boilers shall control primary pumps.
- D. Provide lead/lag control so that lag boilers are energized in stages upon fall of hot water boiler supply temperature in lead boiler (1) to 150°F (adjustable). Alternate operation of boilers will be through DDC system. Energize two (min) boilers below outside temperature of 30°F (adjustable).
- E. Primary pump for each boiler shall run continuously when any boiler is enabled.
- F. Boilers shall utilize Smart Touch Control System for sequencing and control of hot water discharge temperature which shall be reset based on outside air temperature.
- G. Coordinate with Boiler Control Management System supplied (Refer to Section 230570).
- H. Boilers and Pumps are to be enabled in dehumidification mode.

4.2 CONTROL OF VARIABLE SPEED SECONDARY HOT WATER PUMPS (P-3, P-4)

- A. Provide the following to control variable speed pumping systems:
 - 1. Modulate Pumps speed to maintain differential pressure at setpoint
 - 2. Differential pressure transmitters at the ends of the pipe runs (see Drawings)
 - 3. Receiver/Controller
 - 4. All interconnecting wiring and programming.
 - 5. Interface DDC System with pump system drives.
- B. Speed of pumps shall be varied as required to maintain minimum required pressure at end of system. Points shall be monitored and adjustable through the DDC System.

- C. Provide through the DDC System:
 1. On/Off control of each pump
 2. Alarm for each pump
 3. Status of each pump
 4. Percentage speed of each pump
 5. System pressure

4.3 CONTROL OF HOT WATER PUMPS AND HOT WATER SUPPLY TEMPERATURE

- A. Please note that Boiler manufacturer is providing associated control system to provide sequence listed below (refer to Section 230570). Integrate and coordinate with Boiler Manufacturer.
- B. The heating hot water pumps shall be controlled by the DDC System. The lead/lag sequence shall be as follows: The lead pump shall be energized and run continuously. A current transformer shall, through a panel mounted time delay relay, energize the lag pump, and initiate a pilot light alarm upon sensing a loss of flow at lead pump. A panel pilot light will remain lit until the problem has been corrected and then can be reset by pushbutton. The pumps shall automatically alternate weekly through optimal time sequence. Starters for pumps shall be Hand/Off/Auto. When starter is in Auto position, pump shall be controlled by DDC System.
- C. Hot Water Reset Control shall be as follows: The outdoor air master thermostat shall reset the control point of a submaster thermostat with its sensing element in the supply water piping. The panel mounted submaster receiver controller shall modulate a three-way mixing valve located in the hot water supply piping to maintain supply water temperature as listed below:

<u>Outside Air Temperature</u>	<u>Hot Water Supply Temperature</u>
20°	160°F
60°F and above	140°F

4.4 CONTROL OF CHILLERS AND PRIMARY PUMPS

- A. The existing chilled water system consists of air cooled chiller, chilled water pumps with VFD. Loop differential pressure sensor and is set up as a variable primary loop. Outside air temperature and humidity are shared from the Hot Water System Control Panel of the Johnson Metasys BAS Network.

4.5 VAV BOXES – FAN POWERED

- A. Each VAV box shall have a direct digital controller. Multiple VAV boxes controlled by single controller shall not be acceptable. Service technician shall be able to view, change and program all points associated with VAV box from portable service tool plugged into space sensor or a computer.
- B. During the occupied mode, fan shall be energized to run continuously. Primary air control damper shall modulate to maintain space temperature. On a call for heat, air control damper shall go to closed position and reheat coil valve shall modulate to maintain space temperature setpoint.

Occupied heating setpoint shall be 70°F (adjustable) and occupied cooling setpoint shall be 74°F (adjustable).

- C. For dehumidification mode (occupied and unoccupied), on a rise in RH above 60% (adjustable), the VAV box inlet damper shall modulate open, VAV box fan shall be on and HW coil shall reheat air to maintain room temperature setpoint.

4.6 VAV BOXES – NON-FAN POWERED

- A. Each VAV box shall have a direct digital controller. Multiple VAV boxes controlled by single controller shall not be acceptable. Service technician shall be able to view, change and program all points associated with VAV box from portable service tool plugged into space sensor or at computer.
- B. During the occupied mode, primary air control damper shall modulate to maintain space temperature. On a call for heat, air control damper shall go to minimum heating position.
- C. For dehumidification mode (occupied and unoccupied), on a rise of RH above 60% (adjustable), the VAV box inlet damper shall open and the HW coil shall reheat air to maintain room setpoint.

4.7 VAV ROOFTOP AIR HANDLING SYSTEMS

- A. General: The units shall be indexed to the occupied/unoccupied/warm-up modes from the DDC System. Duct smoke detectors mounted in return and discharge air ducts shall, upon sensing alarm conditions, shut down unit fans. A current sensing switch on supply fan shall alarm the DDC System whenever the fan fails. A differential pressure switch across units' filter bank shall display filter pressure drop and alarm the DDC System when filter pressure exceeds a high limit setpoint. On a rise in discharge static above 4" w.c. (adjustable) on leaving side of supply fan, high static limit shall de-energize supply fan and alarm DDC System.
- B. Occupied Mode: When the AH is in the occupied mode, the supply fan shall operate continuously, the variable-frequency drive shall modulate the capacity of the supply fan to maintain the duct static pressure setpoint (adjustable) as measured by a static pressure sensor located approximately 1/3 down supply air duct. The discharge air temperature setpoint shall be reset based on the cooling requirements (if any) of any of the associated spaces served by this unit.
 - 1. For fan-powered VAV boxes, fan shall operate continuously. Room sensor shall modulate VAV box inlet damper and hot water reheat coil to maintain setpoint.
 - 2. For non-fan-powered VAV boxes, room sensor shall modulate VAV box inlet damper and hot water coil to maintain setpoint.
- C. Unoccupied Mode: Fan powered VAV boxes shall be off with inlet dampers closed. Room sensor shall cycle VAV box fans and modulate hot water coil ATC valve to maintain unoccupied setpoint. AH fan shall operate to provide cooling whenever any space calls for dehumidification.
- D. For warm-up cycle, associated VAV boxes shall operate with hot water coils providing heating.

- E. Supply Fan Control: The supply fan will operate continuously whenever the AH is in the occupied mode. The supply fan shall be cycled whenever the AH is in the unoccupied mode and there is a call for cooling during the unoccupied cycle.
- F. Variable Frequency Drive Control: When the supply fan is on, the variable-frequency drive(s) will slowly ramp up (adjustable) and modulate to maintain the proper discharge duct static pressure setpoint and local building static pressure setpoint.
- G. Building Automation System Interface: The Building Automation System (BAS) shall send the AHU a discharge air temperature setpoint. The BAS shall also send start-up, occupied, unoccupied commands.
- H. Points List:
 - 1. Supply Duct Static Pressure (AI)
 - 2. Supply Leaving Air Temperature (AI)
 - 3. Return Air Temperature (AI)
 - 4. Chilled Water Control Valve Position (AO)
 - 5. Smoke Detector (Normal/Alarm) (BI)
 - 6. Dirty Filter (Normal/Alarm) (BI)
 - 7. Supply Fan (On/Off), Alarm (BO, BI)
 - 8. Local Building Static Pressure (AI)

4.8 ROOFTOP AIR HANDLING SYSTEM WITH TOTAL ENERGY WHEEL

- A. General: The units shall be indexed to the occupied/unoccupied/warm-up positions from the DDC System. Freeze detection thermostat shall de-energize the unit fan, close outdoor air damper, open hot water valve (preheat coil) and annunciate alarm upon sensing a coil discharge temperature below its setting. Duct smoke detector mounted in return air and discharge air ducts shall, upon sensing alarm conditions, completely shut down the unit supply fan and exhaust fan, close outside air damper and open return air damper. A current sensing switch on supply fan and exhaust fan shall alarm the DDC System whenever the fan fails. A differential pressure switch across units' filter bank shall display filter pressure drop and alarm the DDC System when filter pressure exceeds a high limit setpoint.
- B. Warm-Up: The unit supply fan shall run continuously. The exhaust fan shall be off. The outdoor air damper shall remain closed, and the unit shall operate on full return air. The room thermostat shall modulate a 2-way ATC hot water valve to maintain room temperature. The outside air and exhaust air bypass dampers shall be closed. The recirculation damper shall be open. The wheel shall be de-energized.
- C. Occupied: The unit supply fan and exhaust fan shall run continuously. The total energy wheel shall be energized with outdoor air and recirculation damper open. The hot water and chilled water ATC valves shall modulate as required to maintain room setpoint. If outdoor air enthalpy level is acceptable, total energy wheel shall be de-energized (economizer mode).
- D. Unoccupied: Outdoor air damper shall be closed, return air damper open. Exhaust fan and total energy wheel shall be de-energized. Hot water coil ATC valve shall be open. On a call for heat by

room thermostat supply fan shall cycle to maintain unoccupied setpoint. The outside air and exhaust air bypass dampers shall be closed. The recirculation damper shall be open.

- E. Room humidistat shall, on a rise of space humidity above 60% (adjustable) modulate chilled water valve open and reheat coil hot water valve open (reheat) as required to maintain desired space temperature and humidity (both occupied and unoccupied cycles).
- F. Points List:
 - 1. Supply Leaving Air Temperature (AI)
 - 2. Discharge Air Temperature – Wheel outlet (AI)
 - 3. Entering Air Temperature – Wheel Inlet (AI)
 - 4. Heating Coil Control Valve Position (AO)
 - 5. Chilled Water Control Valve Position (AO)
 - 6. Reheat Coil Control Valve Position (AO)
 - 7. Return Air, Smoke Detector (Normal/Alarm) (BI)
 - 8. Freezestat (Normal/Alarm) (BI)
 - 9. Dirty Filter (Normal/Alarm) (BI)
 - 10. Supply and Exhaust Fan (On/Off), Alarm (BO, BI)
 - 11. Exhaust Wheel Motor (On/Off), Alarm (BO, BI)
 - 12. Outdoor Air Damper (2) (AO)
 - 13. Outdoor Air Bypass Damper (AO)
 - 14. Exhaust Bypass Damper (AO)
 - 15. Recirculation Damper (AO)
- G. Outside air damper shall be closed and wheel off. When carbon dioxide sensor reaches threshold limit, outside air damper shall modulate open as required and wheel energized. Economizer cycle shall override this control. Sensor shall be located in return air duct.

4.9 CONTROL OF HOT WATER UNIT HEATERS

- A. Single temperature electric space thermostat shall cycle the unit heater fan on and open 2-way electric hot water valve whenever hot water is circulating through the unit heater circuit as sensed by a strap-on aquastat.
- B. The thermostat shall be connected to DDC System.

4.10 CONTROL OF HOT WATER CONVECTORS, CABINET HEATERS, WALL FIN

- A. A single temperature electric thermostat shall modulate the 2-way electric control valve to maintain desired room temperature. For cabinet heaters, fan shall be cycled on a call for heat by thermostat. Provide with thermostat tied to DDC System.
 - 1. Points:
 - a. Fan Status (on/off), Alarm (BO, BI)
 - b. Supply Leaving Air Temperature (AI)
 - c. Heating Coil Control Valve Position (AO)
- B. A common thermostat shall control the wall fin radiation in those spaces that have wall fin radiation installed.

4.11 CONTROL OF EXHAUST FANS, MAKE-UP AIR FANS

- A. Control Type 1: These fans shall be tied into DDC time clock for that respective zone. Fan shall be energized only during the occupied cycle.
- B. Control Type 2: These fans shall be controlled by means of tie-in with wall light switch. Provide time delay (by EC) so that fan operates for 10 minutes (adjustable) after light switch is turned off.
- C. Control Type 3: This fan shall be tied into existing Dishwasher control panel or provided with a switch for manual operation.
- D. Control Type 4: This fan shall be tied into kitchen hood control panel provided by others.
- E. Control Type 5: These fans shall be controlled by a reverse acting thermostat.

4.12 CONTROL OF KITCHEN MAKE-UP AIR UNIT

- A. The kitchen make-up air unit shall be interlocked with kitchen hood controls. Kitchen exhaust fans as controlled by the kitchen hood controls. The kitchen make-up air unit shall operate when kitchen hood exhaust fans operate.
- B. Unit shall be controlled by discharge air temperature sensor to maintain 75°F DAT (cooling – adj) and 70°F DAT (Heating – adj)
- C. OA damper shall open whenever unit is operating.
- D. Smoke detector shall shut down unit and annunciate an alarm when activated.
- E. The kitchen make-up air unit and exhaust fans shall be connected to the kitchen hood fire protection system. When the fire protection system is activated, the make-up air unit fan shall be shut down while exhaust fans shall continue to operate.
- F. The hood system shall signal the make-up air unit controller with the exhaust fan CFM ratio. The kitchen make-up air unit speed shall be controlled to deliver the correct make-up air based on that signal. Required fan speeds to be determined by the Test and Balance Contractor.
- G. Provide the following points and any additional points required to provide control sequence.
 - 1. Sa Fan On-Off and Status
 - 2. SA Fan Speed
 - 3. OA Damper Open-Close
 - 4. Gas Heating – 2 Stage
 - 5. DX Cooling – 2 Stage (1st Stage Modulating, 2nd Stage On-Off)
 - 6. DAT
 - 7. Smoke Detector
 - 8. Clogged Filter Switch
 - 9. Refer to Drawing QF1.10 for additional requirements.

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

- A. General: The units shall be controlled by wall mounted thermostat provided with the unit. Provide a room temperature sensor connected to the DDC System.

4.14 DOMESTIC HOT WATER HEATERS

- A. Domestic hot water heaters are enabled based on need and system requirements. ATC Contractor shall monitor water heater status and alarms. Domestic hot water supply temperature is monitored at the temperature sensor.

4.15 DOMESTIC THERMOSTATIC MIXING VALVE

- A. Domestic thermostatic mixing valve is enabled based on need and system requirements. ATC Contractor shall monitor water heater status and alarms. Domestic hot water supply temperature is monitored at the temperature sensor.

4.16 CONTROL OF DOMESTIC HOT WATER RECIRCULATING PUMPS

- A. Pumps shall be controlled by a strap-on thermostat to maintain the desired hot water temperature in the return line. Pumps shall be tied into DDC schedule system and shall be energized during the occupied cycle and de-energized during the unoccupied cycle. This section applies to the domestic water recirculating pumps. In addition, ATC Contractor shall connect water temperature sensor from the domestic hot water heaters to the master controller on the lead water heater.

4.17 SEQUENCE OF CONTROL FOR GENERATOR

- A. Emergency Generator & ATS: The BAS shall monitor the on/off status of the emergency generator and automatic transfer switches position.
- B. Provide the following sequence for the control of the generator (All by BAS). Upon loss of power the following shall occur:
 - 1. Step 1:
 - a. Turn all equipment connected to the DDC System off.
 - b. Set P-3 & P-4 to OFF. Provide verification back from pump that unit is set to OFF.
 - 2. Step 2:
 - a. Set P-3 & P-4 so only 1 pumps can run. Provide verification back.
 - b. Start one pump and ramp-up speed. Set maximum horsepower at 20 HP. Provide verification back.
 - c. Monitor building load 10 minutes after transfer.
 - 3. After normal power has returned:
 - a. After 20 minutes, return DDC System back to original state.
 - 4. Provide 5 hours additional programming hours for changes to generator sequence.

4.18 POINTS LIST

- A. Refer to following points list.
- B. Refer to Section 230900-1.2 K and L for additional points.
- C. These lists are for information only. Provide total number of points required to provide specified control sequence.

4.19 SEQUENCE OF OPERATION

- A. Through the DDC System, provide the following points and associated sensors, relays, wiring, programming, etc. for each school.
 - 1. Analog Input:
 - a. Temperature and humidity Sensor from each HVAC Zone
 - b. Chilled Water Supply & Return Loop Temperature
 - c. Hot Water Supply and Return Loop Temperature
 - d. Outside Air Temperature and humidity
 - e. 110° and 140° Domestic Water Supply Temperature
 - f. Freezer Temperature (2)
 - g. Refrigerator Temperature (1)
 - h. Bacnet connection to Boiler Control Panel
 - i. Bacnet connection to Chiller
 - 2. Binary Output
 - a. Chiller On/Off (1)
 - b. Boiler On/Off (2)
 - c. Hot Water Pump On/Off (2)
 - d. Chilled Water Pump On/Off (2)
 - e. All Outside Air Dampers Open/closed
 - f. Domestic Water Pump On/Off (2)
 - g. Emergency Generator On/Off
 - 3. Binary Input
 - a. Chiller Status – On/Off (1)
 - b. Boiler Burner Status – On/Off (2)
 - c. Chilled Water Pump Status – On/Off (2)
 - d. Hot Water Pump Status – On/Off (2)
 - e. Boiler Alarm (2)
 - f. Chiller Alarm (1)
 - g. Domestic Water Pump Status (2)
 - h. Fire Alarm Trouble/Alarm
 - i. Switchgear Alarm
 - 4. Programming Notes
 - a. User shall be able to revise day/nighttime schedule for each zone from remote location through DDC Panel.
 - b. If DDC Panel fails, the following shall occur:
 - 1) All zones index to warm-up cycle
 - 2) Hot Water Pump index to ON position
 - 3) Chilled Water Pump indexes to OFF position

- c. All DDC points shall be mapped back into the network for access by any workstation in the network.
- d. Points from chiller and boiler panels shall be connected to network via BACNET MS\TP and interface panels.
- e. High limit shutdown can be done via software from discharge air sensor in lieu of hard wired device.
- f. For sensing if chilled water is available for cooling, it is acceptable to utilize central sensors in lieu of an aquastat at each unit.

END OF SECTION 23 09 00

SECTION 230990 - 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 SCOPE OF WORK

- A. Chilled water system existing, new, and modified shall be rebalanced.
- B. Hot water system existing, new, and modified shall be rebalanced.
- C. Air systems existing, new, and modified shall be rebalanced.

1.5 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. TABWorks.
- B. Eastern Air Balance.
- C. Flood and Sterling.
- D. Butler Balancing.

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.

3.6 AIR SYSTEM PROCEDURE

- 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, exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions.

3.7 WATER SYSTEM PROCEDURE

- 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.

END OF SECTION 230990

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.

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.
- 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.

- 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
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

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.
 - d. Depths of foundations below first floor.
 - e. Locations and depths of underground utilities.
 - f. Revisions to routing of 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.

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 UTILITY COMPANY CONTACTS & COORDINATION

- A. PECO
- B. [Comcast] [] _____
- C. Coordinate with each utility which serves the facility being constructed under this contract.
 - 1. Verify the utility company requirements indicated on Contract Drawings and in the Specifications and adjust as required.
 - 2. Notify the utility company of the date of completion of those portions of the work which are provided for utility company use.
 - 3. Make all other notifications requested by the utility.
 - 4. Provide equipment submittals as necessary for Utility review and approval.
- D. The Owner will pay all utility company service costs.
- E. Contractor to verify with the various Utility Company's exact location of their facilities and exact location for terminating the service conduits before starting any work and adjust as required.

1.16 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.

1.17 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.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc., or other testing firms acceptable to the authority having jurisdiction.

1.18 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.

1.19 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.

1.20 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.

1.21 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.

1.22 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 detectable warning tape above all underground services, properly identifying each type of service.

1.23 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.

1.24 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.

1.25 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.

1.26 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.

1.27 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.

1.28 ACCESS

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

1.29 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.

1.30 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.

1.31 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.

1.32 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.

1.33 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.

1.34 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) 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.

1.35 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.

1.36 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.

1.37 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. 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.
 - 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

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.
- 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 – Provide temporary generator and fuel supply as required to maintain school operations during new generator installation.

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.
- 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.
- 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

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.
- 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.
 - 3. Check three phase equipment for proper rotation. Change rotation as required.
- D. Wheelchair Lift:
 - 1. Provide fused disconnect switch and wire thru to wheelchair lift.
 - 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.
 - 4. Coordinate height and location of disconnect switch with approved wheelchair lift shop drawing and GC.
 - 5. Provide category 6 cable to building demark in 3/4" conduit.
- E. Smoke Dampers:
 - 1. Provide a disconnect switch, enclosed contactor, and fire alarm auxiliary relay for each smoke damper.

2. Provide 2#10 + 1#10 gnd in 3/4" conduit through the contactor and disconnect switch to damper motor from the nearest 120/208V panelboard.
 3. Provide fire alarm wiring between auxiliary relay and fire alarm panel.
 4. Auxiliary relay shall control the contactor as required.
- F. Site Sign (Unless otherwise noted on the Drawings):
1. Provide 3#4 + 1#4 gnd in 2" conduit from nearest 120/208V panelboard to site sign and terminate on both ends.
 2. Provide fiber optic cable (or as required by sign manufacturer) in 1" conduit from junction box in nearest MDF/IDF closet to site sign and terminate as directed.
 3. Verify exact location of site sign with site drawings.
- G. Hood Lighting:
1. Provide switches, wiring and conduit as required for lighting fixtures provided with hood unless otherwise noted.
- H. Motorized Folding Partition:
1. Provide fused disconnect switch and wire thru to folding partition.
 2. Coordinate size and voltage of disconnect switch with approved shop drawing.
 3. Provide all control wiring and install switches furnished with unit.
 4. GC shall provide all safety wiring and install all safety interlocks furnished with unit. EC shall provide all rough-ins and raceways.
- I. 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.
- J. Motorized Divider Curtain:
1. Provide local disconnect switch and wire thru to divider curtain.
 2. Coordinate size and voltage of disconnect switch with approved shop drawing.
 3. Provide all control/safety wiring in 3/4" and install controls furnished with unit.
- K. Motorized Projection Screens:
1. Provide local disconnect switch and wire thru to projection screen.
 2. Coordinate size and voltage of disconnect switch with approved shop drawing.
 3. Provide all interconnecting wiring and install controls furnished with unit.
- L. Motorized Basketball Backstop Raise/Lower:
1. Provide extra hard usage flexible cord with twist lock cord connector on motor.
 2. Provide matching twist lock receptacle connected to circuit.
 3. Provide conductors sizes as required by manufacturer's instructions.
 4. Provide all control/safety wiring in 3/4" conduit and install controls furnished with unit.
- M. Motorized Basketball Backstop Height Adjuster:
1. Provide extra hard usage flexible cord with twist lock cord connector on motor.
 2. Provide matching twist lock receptacle connected to circuit.
 3. Provide conductors sizes as required by manufacturer's instructions.
 4. Provide all control/safety wiring in 3/4" conduit and install controls furnished with unit.

- N. 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.
- O. Premanufactured Display Case:
 - 1. Provide installation and all interconnecting wiring for luminaires, switches and receptacles furnished with the display case.
- P. On-Site Built Display Case:
 - 1. Provide luminaires to light the entire display case with switch for control.
 - 2. Provide a duplex receptacle mounted in location directed by the Architect.
- Q. 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.
- R. Kiln:
 - 1. Provide extra hard usage flexible cord with twist lock cord connector on kiln.
 - 2. Provide fused disconnect with matching twist lock receptacle connected to circuit.
 - 3. Provide local disconnect/receptacle for integral kiln vent connected to circuit.

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:

		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.	Fan Powered VAV Boxes (FPV) (VAV)		
	a. Furnish and install unit	X	
	b. Local Disconnect Switch		X
	c. Power wiring thru starter and disconnect to terminals		X
	d. Control wiring	X	
	e. Tester/Overload Protection	X	

		DIV 23	DIV 26
6.	Non-Fan Powered VA Boxes (V) (VA)		
	a. Furnish and install unit	X	
	b. Local Disconnect Switch		X
	c. Power wiring thru disconnect to transformer		X
	d. Control wiring	X	

		DIV 23	DIV 26
7.	Vertical Unit Ventilators (UV)		
	a. Furnish and install unit	X	
	b. Integral Circuit Breaker	X	
	c. Power wiring to disconnect on unit		X
	d. Control wiring	X	

		DIV 23	DIV 26
8.	Horizontal Unit Ventilators (UV)		
	a. Furnish and install unit	X	
	b. Thermal Toggle Switch		X
	c. Power wiring thru disconnect to unit		X
	d. Control wiring	X	

		DIV 23	DIV 26
9.	Electric Wall Heater (EWH)		
	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
10.	Electric Unit Heaters and Electric Cabinet Heaters (EUH) (ECH)		
	a. Furnish and install unit	X	
	b. Fused Disconnect Switch		X
	c. Power wiring thru disconnect to unit		X
	d. Control wiring	X	

		DIV 23	DIV 26
11.	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
12.	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	

		DIV 23	DIV 26
13.	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
14.	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
15.	Kiln Vent System		
	a. Furnish and install unit	X	
	b. Receptacle mounted at height required		X
	c. Coiled cord from receptacle to fan motor	X	

		DIV 23	DIV 26
16.	Rooftop Units (RTU)		
	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
17.	Ventilation/Supply Units (VS)		
	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
18.	Heat Recovery Units (HRU)		
	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
19.	Blower Coil 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
20.	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
21.	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
22.	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

		DIV 22	DIV 26
23.	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
24.	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 21	DIV 26
25.	Fire Pump Controls		
	a. Pumps, Fire Pump Controller and Disconnect	X	
	b. Jockey Pump Disconnect and all related Electrical Connection to Fire Pump & Controller		X

		DIV 23	DIV 26
26.	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. Display Cases
 6. Motorized Shades
 7. Wheelchair Lifts
 8. Motorized Projection Screens
 9. Kilns
 10. Kitchen Equipment
 11. Hoods
 12. Motorized Basketball Backstops

13. Motorized Divider Curtain
14. Scoreboards
15. Smoke Dampers
16. Gymnasium Equipment & Controls
17. Theatrical Rigging, Winches, and Operators
18. Wrestling Mat Hoists
19. Site Signs
20. Dryers
21. Water Coolers

- B. The equipment supplier shall provide wiring (point to point) diagrams where the Electrical Contractor is to make final connections.
- 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.
- 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

SECTION 260513 – MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Medium Voltage Cable
- B. Cable Terminations

1.2 REFERENCES

- A. ANSI/IEEE C2 - National Electrical Safety Code
- B. ANSI/IEEE 404 - Power Cable Joints
- C. ANSI C57.12.28 - Switchgear and Transformer, Pad-mounted Equipment Enclosure Integrity
- D. ANSI/NFPA 70 - National Electrical Code
- E. IEEE 48 - Test Procedures and Requirements for High- Voltage Alternating-Current Cable Terminations
- F. NEMA WC 7 - Cross-Linked-Thermosetting-Polyethylene- Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
- G. NEMA WC 8 - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
- H. ICEA S-93-639/NEMA WC 74 Shielded Power Cable 5-46KV (Updated Standard)
- I. AEIC CS8 – Specification for ethylene propylene rubber insulated shielded power cables rated 5 through 69KV
- J. UL 1072 – Medium Voltage Power Cables

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, but not limited to, 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, terminations and accessories with specific item or model number highlighted.

- d. Certification and Test Report to indicate results for specified factory and field testing and inspection.
- e. Submit manufacturer's installation instructions.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Accurately record actual sizes and locations of cables on As-Built Drawings.
- C. Maintenance Data: Include instructions for testing and cleaning methods; cleaning materials recommended; procedures for sampling and maintaining fluid.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.
- B. Installer: Company specializing in installing 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 Underwriters Laboratories, Inc., or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle Products to site.
- B. Accept cable and accessories on site in manufacturer's packaging. Inspect for damage.
- C. Store and protect in accordance with manufacturer's instructions.
- D. Protect from weather. Provide adequate ventilation to prevent condensation.

1.8 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of cable bank prior to rough-in.
- C. Cable routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

1.9 UTILITY COMPANY COORDINATION

- A. Provide cable approved by the serving electric utility.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Southwire Company
- B. Okonite Company
- C. Prysmian Group

2.2 MEDIUM VOLTAGE POWER CABLE AND FIELD TESTING

A. EPR Cable:

1. General (EPR):

- a. Scope: This part covers single conductor, ethylene propylene rubber insulated, shielded, and jacketed power cable for use at 5,000 or 35,000 volts, 133% insulation level. Cable shall be rated at 105°C for normal operation; 140°C for emergency overload conditions and 250°C for short circuit conditions. Cables shall be UL listed and designated MV-105 in accordance with the National Electrical Code.

2. Cable:

- a. Basic Construction: Cable shall have a single Class B stranded bare copper conductor, extruded semi-conducting conductor screen, ethylene propylene rubber insulation, extruded semi-conducting insulation screen, copper tape shielding and extruded PVC jacket. The cable conductor screen, insulation and the insulation screen shall be manufactured by employing an in-line triple-tandem extrusion process.
- b. Conductor: The conductor shall be Class B compressed soft or annealed copper in accordance with ASTM B-3 and B-8 and ICEA Part 2, Section 2.1 and 2.5
- c. Conductor Screen: The conductor shall be shielded with an extruded semi-conducting thermosetting polymeric layer over the conductor. The conductor screen shall be clean stripping from the conductor and firmly bonded to the insulation. The thickness shall be in accordance with the referenced standards.
- d. Insulation: 133% insulation level, environmentally friendly non-leaded, white ethylene propylene rubber with physical and electrical characteristics that comply with the requirements of ICEA Standard S-93-639.

- 15 KV – 220 Mils

The thickness at any cross-section of the insulation shall not be less than 90% of the specified thickness.

- e. Insulation Screen: The insulation shall be shielded with an extruded layer of semi-conducting thermosetting material. The thickness shall be in accordance with the referenced standards.

- f. Metallic Shield: A helically wrapped 5-mil copper tape shield shall be applied over the insulation screen with a minimum overlap of not less than 26%.
- g. Cable Jacket: The cable shall be provided with a jacket of black sunlight resistant no lead PVC conforming to the requirements specified in ICEA. The average thickness shall be in accordance with Table 7-3 of ICEA.
- h. Identification: The following information shall be permanently printed every 24" on the surface of the jacket.
 - 1) Manufacturer
 - 2) Conductor Size and Type
 - 3) Insulation Type and Thickness
 - 4) % Insulation Level
 - 5) Rated Voltage
 - 6) MV-105
 - 7) Year Manuf.
- 3. Factory Testing and Certification:
 - a. DC Resistance Test: Conductor DC resistance shall meet the requirements of ICEA S-93-639.
 - b. AC and DC Voltage Tests: Each reel of cable shall be subjected to AC and DC tests in accordance with Part 6 of ICEA per the cable rated voltage for 133% insulation level. The cable shall be given a 5-minute AC voltage withstand test and 15-minute DC voltage withstand test.
 - c. Insulation Resistance: Insulation resistance shall be measured and recorded in megohms per 1,000' and when corrected to 15.6°C the series insulation resistance shall not be less than 50,000 megohms per 1,000'.
 - d. Corona Discharge: Each reel of cable shall be given a corona discharge test. The test shall be in accordance with AEIC #CS-8, latest edition. An X-Y recording graph shall be furnished showing corona test results. The maximum partial discharge allowed is 5 pico coulombs.
 - e. Certification: For each reel of cable, a certified and notarized factory test report, reel numbers for cable identification with date of manufacture and testing shall be submitted.

B. XLP Cable:

- 1. General:
 - a. Scope: This part covers single conductor, cross linked polyethylene insulated, shielded, and jacketed power cable for use at 5,000 or 35,000 volts, 133% insulation level. Cable shall be rated at 90°C for normal operation; 130°C for emergency overload conditions; 250°C for short circuit conditions. Cables shall be UL listed and designated MV-90 in accordance with the National Electrical Code.
 - b. Standards: The cable shall meet or exceed the industry standards of the latest edition of ICEA-NEMA Standard S-93-639 and AEIC Standards.
- 2. Cable:
 - a. Basic Construction: Cable shall have a single Class B stranded bare copper conductor, extruded semi-conducting conductor screen, cross-linked polyethylene insulation, extruded semi-conducting insulation screen, copper drain wire shielding and extruded PVC jacket. The cable conductor screen, insulation and the insulation screen shall be manufactured by employing an in-line triple-tandem extrusion process.

- b. Conductor: The conductor shall be Class B compressed soft or annealed copper in accordance with ASTM B-3 and B-8 and ICEA Part 2, Section 2.1 and 2.5
- c. Conductor Screen: The conductor shall be shielded with an extruded semi-conducting thermosetting polymeric layer over the conductor. The conductor screen shall be clean stripping from the conductor and firmly bonded to the insulation. The thickness shall be in accordance with the referenced standards.
- d. Insulation: Cross-linked polyethylene with physical and electrical characteristics that comply with the requirements of ICEA Standard S-93-639. The insulation thickness shall be as follows for 133% insulation level:

- 5 KV – 115 Mils
- 15 KV – 220 Mils
- 35 KV – 420 Mils

The thickness at any cross-section of the insulation shall not be less than 90% of the specified thickness.

- e. Insulation Screen: The insulation shall be shielded with an extruded layer of semi-conducting thermosetting polymeric material. The thickness shall be in accordance with the referenced standards.
- f. Metallic Shield: A concentric serve of 24 AWG annealed solid bare copper wires shall be applied over the insulation screen. A non-metallic separator tape shall be helically applied over the metallic wire shield.
- g. Cable Jacket: The cable shall be covered with a black sunlight resistant Polyvinylchloride jacket meeting the physical requirements of ICEA. The jacket shall have a minimum average thickness in accordance with Table 7-3 of ICEA.
- h. Identification: The following information shall be permanently printed every 24" on the surface of the jacket.
 - 1) Manufacturer
 - 2) Conductor Size and Type
 - 3) Insulation Type and Thickness
 - 4) % Insulation Level
 - 5) Rated Voltage
 - 6) MV-90
 - 7) Year Manufactured

3. Factory Testing and Certification:

- a. DC Resistance Test: Conductor DC resistance shall meet the requirements of ICEA S-93-639.
- b. AC and DC Voltage Tests: Each reel of cable shall be subjected to AC and DC tests in accordance with Part 6 of ICEA per the cable rated voltage for 133% insulation level. The cable shall be given a 5-minute AC voltage withstand test and a 15-minute DC voltage withstand test.
- c. Insulation Resistance: Insulation resistance shall be measured and recorded in the megohms per 1,000' and when corrected to 15.6°C the series insulation resistance shall not be less than 0,000 megohms per 1,000'.
- d. Corona Discharge: Each reel of cable shall be given a corona discharge test. The test shall be in accordance with AEIC, latest edition. An X-Y recording graph shall be furnished showing corona test results. The maximum partial discharge allowed is 5 pico coulombs.

- e. Certification: For each reel of cable, a certified and notarized factory test report, reel numbers for cable identification with date of manufacture and testing shall be submitted.
- C. Field Testing:
- 1. General:
 - a. Scope: Field testing cables, splices and terminations shall consist of a non-destructive, direct current, dielectric test of insulation of primary cable system using ICEA standard procedure.
 - b. The Electrical Contractor shall notify the Architect/Engineer 2 weeks prior to the date of tests.
 - c. Testing shall be by an independent testing firm acceptable to the Architect/Engineer. Testing is not to be by the Electrical Contractor. All tests shall be made by a qualified field technician specially trained for dielectric testing and interpretation of results and regularly engaged in dielectric testing.
 - d. The Electrical Contractor shall be responsible for disconnecting and reconnecting existing equipment as required to make these tests.
 - e. If at any time during the test procedure, the test is stopped due to excessive readings, the installation shall be checked to locate the problems. Corrective measures shall be taken prior to continuing the test.
 - 2. Cable, Splicing and Termination Testing:
 - a. Scope: All new cables, including all splices and terminations, shall be tested after installation prior to being energized. All cables not under test shall be properly grounded and tied to the shield of the cable under test. If it is necessary to repeat a test, the capacitance and absorption current shall be discharged by grounding the conductor for sufficient time to allow complete drainage. If the cable has been energized prior to testing, the capacitance shall be completely discharged by grounding the conductor in an approved manner.
 - b. Field Testing: Tests performed and recorded shall be of the following types:
 - 1) Step Voltage Tests for New Cable circuits.
 - 2) Step Voltage and Time Resistance (Polarization Index) Tests for Existing Circuits.
 - c. An installation having only new cable, splices and termination shall be tested as follows:
 - 1) 5 KV Systems – Test to 25 KV D.C.
 - 2) 15 KV System – Test to 55 KV D.C.* (* 64 KV DC for cable only)
 - 3) 35 KV System – Test to 95 KV D.C.
 - 4) Under no circumstances is the test voltage to exceed 80% of the manufacturer's original D.C. over-voltage acceptance test.
 - d. An installation consisting of a combination of new and existing cables, splices and terminations shall be tested as follows:
 - 1) 5 KV Systems – Test to 20 KV D.C. provided the existing system passes the meggar test.
 - 2) 15 KV System – Test to 35 KV D.C. provided the existing system passes the meggar test.
 - 3) 35 KV System – Test to 65 KV D.C.
 - 4) Lower test voltages may be used upon direction from the Engineer.

- 5) Under no circumstances is the test voltage to exceed 60% of the manufacturer's original D.C. over-voltage acceptance test.
 - e. The results shall be plotted in the form of a curve on kilovolt-megohm paper.
 - f. In the step voltage tests, voltage shall be applied evenly to the insulation in 10 consecutive steps of a specified magnitude or steps equal to the kilovolt rating (whichever is the lower), starting at a pre-selected and specified initial value. Voltage shall be held at each step for 1 minute and current readings shall be taken and recorded at the end of each 1-minute period for each voltage step. For certain very long cables, the test current will not have stabilized at the end of 1 minute. In these cases, each step shall be held for 2 minutes or for sufficient time to allow for stabilization of the capacitance and absorption currents. In conducting the test, the voltage shall not be increased or decreased during the time-period. At the completion of the step voltage test and when the maximum specified voltage is achieved, the voltage shall be held at this maximum for 10 minutes and current readings taken and recorded.
 - g. In the Polarization Index Test, a specified constant test voltage shall be applied for 10 minutes to each conductor, recording insulation resistance at $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 minute and every minute thereafter. The Polarization Index (ratio of 10-minute insulation resistance to 1-minute insulation resistance) shall be at least 1.00 to permit application of high potential in the Step Voltage Test.
3. Test Results:
- a. Determination: A determination is to be made by the testing firm field technician as soon as the test is completed, as to whether or not the system should be energized.
 - b. Distribution: Nine (9) certified copies of the field test reports shall be furnished to the Engineer through the Architect for approval, and shall include the following:
 - 1) All readings shall be recorded and plotted on kilovoltmegohm paper.
 - 2) A written summary by the tester as to the conditions of the installation, and recommendations relative to the acceptability of the installation.
 - c. In the event that the Engineer concludes that the test results are marginal, another test shall be run prior to the expiration of the 1-year bonding period. The test shall be arranged for and paid for by the Electrical Contractor.

2.3 SPLICE KITS

- A. Connectors: IEEE 404, compression type, as recommended by cable or splicing kit manufacturer for the application,
- B. Splicing Products: As recommended in writing by the splicing kit manufacturer for the specific sizes, ratings, and configurations of cable conductors and splices specified. Include all components required for complete splice, with detailed instructions.
 1. Modular Molded Rubber Terminations: IEEE 48; Class 1, kit form; and indoor/outdoor application suitable for use with cable specified, including the following:
 - a. Stress cone with rubber modules, lugs, and ground clamp.

2.4 SOLID TERMINATIONS

- A. Conductor Terminations: Comply with IEEE Standard 48, as indicated. Insulation class equivalent to that of the cable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify installation conditions before proceeding with work.
- B. Verify that duct is ready to receive cable.

3.2 PREPARATION

- A. Use swab to clean ducts before pulling cables.

3.3 INSTALLATION

- A. Install cable, splices, terminations, and accessories in accordance with manufacturer's instructions.
- B. Avoid abrasion and other damage to cables during installation.
- C. Use suitable lubricants and pulling equipment.
- D. Do not exceed cable pulling tensions and bending radius.
- E. Ground cable shield at each termination and splice.
- F. Install cables in manholes along wall providing longest route.
- G. Arrange cable in manholes to avoid interference with duct entrances.
- H. Fireproof cables in manholes using fireproofing tape in half-lapped wrapping. Extend fireproofing 1" into duct.
- I. Install circuit and cable identification tags in accordance with Section 260553.

3.4 FIELD QUALITY CONTROL

- A. Inspect exposed cable sections for physical damage.
- B. Inspect cable for proper connections as shown on Drawings.
- C. Inspect shield grounding, cable supports, and terminations for proper installation.

3.5 PROTECTION

- A. Protect installed cables from entrance of moisture.

END OF SECTION 260513

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.

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

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.

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.
- 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

SECTION 260520 – FIRE RATED POWER CONDUCTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire Rated Conductors
- B. Fire Resistant Armored Power Cable

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. ANS /UL 2196 - Tests for Fire Resistive Cables
- C. UL Fire Resistance Directory

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, but not limited to, 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, terminations and accessories with specific item or model number highlighted.
 - d. UL listing of conductors (FHIT document).
 - e. Letter from the AHJ that approves the proposed installation meets the 2-hour fire rating.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Accurately record actual sizes and locations of cables on As-Built Drawings.

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. Conform to requirements of the Electrical Circuit Protective System listing in the UL Fire Resistance Directory.
- C. 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.

1.7 PROJECT CONDITIONS

- A. Conductor sizes are based on copper. Substitution of aluminum for conductors specified as copper is not permitted.
- B. 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.
- C. Where wire and cable routing are not shown, and destination only is indicated, determine exact routing and lengths required.

1.8 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 FIRE RATED CONDUCTORS

- A. Manufacturers: Draka (Prysmian Group)
- B. Cable Types:
 - 1. RHW-2
 - 2. RW90
- C. Ratings:
 - 1. Listed to UL 44, Thermoset Insulated Wires and Cables, as the following type:
 - a. RHW-2, 600 Volt, Rated 90°C Dry/90°C Wet
 - b. RW90, 600 Volt, Rated 90°C Dry/90°C Wet
 - 2. Listed to UL 2196, Standard for Tests for Fire Resistive Cables, for two-hours in horizontal (H) installations in EMT (FHIT 25C).
 - 3. Listed to UL 2196, Standard for Tests for Fire Resistive Cables, for two-hours in horizontal (H) or vertical (V) installations in FRE BreathSaver® (FHIT 25C).
 - 4. Electrical Circuit Integrity System (FHIT) No. 25C of the UL Fire Resistance Directory.
 - 5. Sunlight Resistant
 - 6. FT4 Rated
 - 7. ST1
 - 8. IEEE 1202
 - 9. NFPA 70, NFPA 101, NFPA 130, NFPA 502 compliant.

- D. Design Parameters:
 - 1. Conductors: Bare stranded copper, 8 AWG through 750kcmil.
 - 2. Insulation: High Temperature Mica Tapes layer, Ceramifiable silicone, Low Smoke Zero Halogen (LSZH).
 - 3. Jacket: Cross-linked polyolefin (XLPO), Low Smoke Zero Halogen.
- E. Conduit Sizes:
 - 1. Provide the increased EMT/FRE BreathSaver conduit size required by the manufacturer.
 - 2. Use manufacturers' data to calculate conduit fill.
 - 3. Contact manufacturer for sizing assistance.
- F. Pull Boxes: Pull boxes are permitted per FHIT 25C
 - 1. Manufacturer and type of box is outlined in the manufacturer document Technical Information Sheet 301H (TIS 310H) and FHIT 25C.
 - 2. Box shall be sized 8 times the largest raceway size per NEC Article 314.28.
 - 3. Pull boxes can be utilized to change conduit types outlined in FHIT 25C.
 - a. If FRE BreathSaver conduits are to be used, the pull box must be a Resolve One enclosure per TIS 301H.
- G. Splices: Avoid cable splices in the fire zone when possible. If splicing is required, they must be performed in accordance with FHIT 9 for a 3-Hour rating (5 wraps of protective matting).

2.2 FIRE RESISTANT ARMOURED POWER CABLE

- A. Manufacturers: Draka (Prysmian Group)
- B. Cable Types: Lifeline MC
- C. Ratings:
 - 1. UL-1569, Metal Clad Cables: 600 Volt, Rated 90°C Dry/90°C Wet
 - 2. Listed to UL 2196, Standard for Tests for Fire Resistive Cables, for two-hours in horizontal (H) installations and two-hour in vertical (V) installations per FHIT 50.
 - 3. Sunlight Resistant
 - 4. FT4 Rated
 - 5. ST1
 - 6. Wet Locations
 - 7. IEEE 1202
 - 8. NFPA 70, NFPA 101, NFPA 130, NFPA 502 compliant.
- D. Construction:
 - 1. Conductors: Bare stranded copper, 14 AWG through 600 kcmil (1/0 AWG to 750 kcmil on single conductor).
 - 2. Insulation: Ceramifiable Silicone Zero Halogen (LSZH).
 - 3. Inner Binder: Ceramifiable Silicone Zero Halogen (LSZH).
 - 4. Armour: Continuously welded corrugated copper.
 - a. Note: Armor will meet ground conductor requirements of NEC Table 250.122
 - 5. Sheath (if applicable): Thermoplastic flame-resistant Low Smoke Zero Halogen (LSZH)

- 6. Conductor Identification: Each conductor on multi-conductor cables will be numerically identified.
- E. Physical Characteristics:
 - 1. Voltage rating: 600 volts
 - 2. Operating temp:
 - a. Rated 90°C Dry/90°C Wet
 - b. The cable should not be installed when either the ambient or cable temperature is below 0°C.
 - 3. Min, bending radius: 7 x overall diameter of cable
- F. Splices: Avoid cable splices in the fire zone when possible. If splicing/pull boxes are required, cable sizes #2 AWG and larger may be completed per FHIT 50 and TIS 403. For sizes #3 AWG and smaller, splicing/pull boxes must be performed in accordance with FHIT 9.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that no moisture has entered cable insulation.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Install cables per applicable FHIT document and manufacturers' instructions.
 - 1. Lifeline RHW-2 installed in EMT conduit, in a Horizontal A(H) position, can incorporate a vertical offset of no more than 10', each end, of Horizontal (H) run.
 - 2. Vertical runs in FRE BreathSaver conduit must have Resolve One enclosure installed as cable support (chalk box) every 24'.
- B. Use Polywater LZ wire pulling lubricant if required.
- C. Protect exposed cable from damage.
- D. Modify as required for the installation of lug adapters, crimp on reducers and hardware, as necessary, to terminate conductors on equipment.
- E. Clean conductor surfaces before installing lugs and connectors.

3.4 INTERFACE WITH OTHER PRODUCTS

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

3.5 FIELD QUALITY CONTROL

- A. Perform field inspection and testing.
- 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.
- E. Inspect to ensure installation is per the applicable FHIT document and or manufacturers recommendations.

END OF SECTION 260520

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.

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.
- 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.
- 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. Ladder Tray (Section 260537): 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

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:
 - 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.
- 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.
- 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

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
- 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.

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.

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
- 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".
- 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.
- 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 luminaries 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.
- 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.
- 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

SECTION 260534 – SURFACE RACEWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Surface Metal Raceways

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.
- 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 (V2400BD 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 ivory ScuffCoat (a polyester topcoat over an ivory 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 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.

2.3 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, ivory, 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.

2.4 EXTRA DEEP SURFACE MOUNTED DEVICE BOX (V5744-2 Series)

- A. Two-gang, 2.88 inches depth minimum, surface mounted outlet box.
- B. Materials: The raceway and all system components must be UL Listed. Steel shall be galvanized. Finish shall be gray, ivory, or custom colored and be suitable for field repainting to match surroundings.

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

SECTION 260537 – LADDER TYPE CABLE TRAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cable Trays and Accessories

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. ASTM A 123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
- C. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated Galvanized by the Hot-Dip Process
- D. NEMA VE 1 - Metallic Cable Tray 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 in the system.
 - c. Data sheets to indicate tray type, dimensions, support points and finishes with the specific item or model number highlighted.
 - d. Data sheets for all barrier strips, conduit clamps, grounding clamps, bonding jumpers, and wall penetrations with the specific item or model number highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual routing of cable tray and locations of supports.
- C. Maintenance Data: Include spare parts listing recommended maintenance procedure and intervals.

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 Underwriters Laboratories, Inc., or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

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. Bonding Jumpers: Furnish 6 of each type installed.
 - 2. Conduit Clamps: Furnish 6 of each type installed.
 - 3. Grounding Clamps: Furnish 6 of each type installed.

1.8 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Legrand Cablofil
- B. Hubbell
- C. Cooper B-Line
- D. T.J. Cope
- E. Thomas & Betts
- F. Mono-Systems

2.2 LADDER-TYPE CABLE TRAY

- A. Description: NEMA VE 1, Class 12B ladder type tray.
- B. Material: Steel or Aluminum.
- C. Finish: ASTM A 123, hot dipped galvanized after fabrication (steel only).
- D. Usable Inside Width: Provide trays that are 12" wide when measured between inside faces of the rails unless otherwise noted on the plans.
- E. Usable Inside Depth: Provide trays that have a 4" usable depth when measured from the top of the cross rung to the top of the rail.

- F. Straight Section Rung Spacing: 6" on center.
- G. Inside Radius of Fittings: 12"
- H. Provide manufacturer's standard barrier strip with all manufacturer supplied hardware, barrier splice strips and barrier strip clamps. Install in the center of the tray for all cable tray in this project. Barrier strip not required at horizontal cross and horizontal tee connections ONLY.
- I. Provide manufacturer's standard conduit clamps for all conduit connected to cable tray.
- J. Provide manufacturer's standard grounding clamps for all grounding conductors connected to cable tray.
- K. Provide manufacturer's standard bonding jumpers on both sides between all sections of the cable tray.
- L. Provide manufacturer's standard wall penetration sleeve for all wall penetrations.
- M. Provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, grounding straps and all other apparatus as required.
- N. Covers: None.

2.3 WARNING SIGNS

- A. Engraved Nameplates: 1/2" high black letters on yellow laminated plastic nameplate, engraved with the following wording, (provide on all trays):
 - 1. WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!
 - 2. Where cable trays are used for signal and power limited cables: WARNING: DO NOT RUN POWER WIRING WITHIN THIS TRAY. CABLES SHALL BE SIGNALING AND POWER LIMITED CIRCUITS OPERATING AT 50 VOLTS OR LESS.

2.4 FIRE STOPPING

- 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. 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

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install metallic cable tray in accordance with NEMA VE 1.
- C. Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports of 5'.
- D. Install cable tray in such a manner that joints are not made at support brackets.
- E. Install support within 2' on each side of expansion joints and within 2' of fitting extremity.
- F. Provide expansion joints in accordance with NEMA VE-1 for 25°F maximum temperature variation.
- G. Provide expansion connectors at each expansion and control joint in the building structure and at 200' intervals in interior locations.
- H. Ground and bond cable tray under provisions of Section 260526.
 - 1. Provide grounding continuity between tray components with manufacturer's grounding straps over the entire length of the tray.
 - 2. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
 - 3. Provide bare copper equipment grounding conductor where required by the National Electrical Code.
 - 4. Provide bonding jumper at each expansion joint and adjustable connection.
 - 5. Connections to tray may be made using mechanical or exothermic connectors.
- I. Install warning signs at 50' centers along cable tray on both sides.
- J. Provide offsets and saddles in tray runs where required for coordination with the installation of the products of this contract and other contracts.
- K. Provide the manufacturer's standard connections at all joints. Provide runs of tray, which are mechanically and electrically continuous from end to end.
- L. Provide a reinforced concrete lintel where cable tray penetrates a "CMU" wall. The lintel shall be of the same height and depth as the "CMU" by length as required to properly span the opening.
- M. Provide fire stopping where cable tray penetrates walls, smoke/fire door partitions etc.

3.2 TRAY USAGE

- A. The cable tray is intended to serve the following cabling systems:
 - 1. Left Side of Barrier Strip:
 - a. Intercom system speakers, call switches and related devices.
 - b. Master and secondary clock wiring (Low voltage only)
 - c. Fiber optic cables in interduct
 - d. Telephone branch and trunk cables
 - e. CATV cables.
 - f. Computer network cables
 - 2. Right Side of Barrier Strip
 - a. ATC System cables - by others.
 - b. Security System Cables
 - c. Fire alarm cables, cables which supply strobe units must be power-limited types approved for use in tray with low-voltage cables. Otherwise, run 120-volt circuits in conduit.
- B. Non-power-limited circuits, which are associated with cable tray cables, such as fire alarm signaling or 120V clock wiring must be run in conduit.

END OF SECTION 260537

SECTION 260543 – UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit
- B. Duct
- C. Metallic Warning Tape
- D. Innerduct
- E. Access Structures:
 - 1. Manholes
 - 2. Handholes
 - 3. Transformer Vault

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
- 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.

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 MANHOLE MANUFACTURERS

- A. A. C. Miller Concrete Products
- B. Monarch Precast Concrete Company
- C. Terry Hill Concrete Products
- D. Rotondo Precast Company

2.5 PRECAST CONCRETE MANHOLES

- A. Material: Reinforced precast concrete, air-entrained, 3500 PSI compressive strength at 28 days.
- B. Construction: Monolithic or modular sections with tongue-and-groove joints.
- C. Reinforcing: AASHTO Classification H-20.
- D. Shape: Square or as required by Utility Company. (Verify)

- E. Nominal Inside Dimensions: 6' x 6' or as required by the Utility Company. (Verify)
- F. Inside Depth: 6' or as required by the Utility Company. (Verify)
- G. Wall Thickness: 6"
- H. Base Section: Include 12" (diameter or square) x 4" deep sump with cast sleeve, and two 1" ground rod openings.
- I. Top Section: Include 36" diameter grooved opening for frame and cover.
- J. Riser Casting: 12" with manhole step cast into frame.
- K. Frames and Covers: ASTM A48; Heavy Duty; Class 30 gray cast iron, 30" round cover, lifting rings, ribbed squares on top surface.
- L. Logo: Provide cover marked with 4" high cast letters to indicate utility, (Electric or Telecommunications).
- M. Duct Entry Provisions: Window knockouts.
- N. Duct Entry Locations: As required by project conditions.
- O. Cable Pulling Irons: 7/8" diameter steel bar forming a triangle of 9" per side when set. Galvanize to ANSI/ASTM A153 for irregular shaped articles. Locate opposite each duct entry.
- P. Cable Rack Inserts: Steel channel insert with minimum load rating of 800 pounds, length to match cable rack channel.
- Q. Cable Rack Mounting Channel: 1-1/2" x 3/4" steel channel wall bracket, 48" length, with cable rack arm mounting slots on 8" centers.
- R. Cable Racks: Heavy duty steel channel, 2-1/2" x 3/4" x 14", with fastener to match mounting channel.
- S. Cable Supports: Porcelain clamps and saddles installed on 3' maximum centers.
- T. Manhole Ladder: Hot dipped galvanized steel, full height of manhole.
- U. Sump Covers: ASTM A48, Class 30 gray cast iron.

2.6 HANDHOLES

- A. Material: Glass Fiber reinforced polymer concrete. UL Listed.
- 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. Driveways, parking lots, and other paved areas subject to heavy vehicular traffic: AASHTO H-20.
 2. Provide Tier 22 for all other areas.
- 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.
- 2.7 PRECAST CONCRETE TRANSFORMER VAULT
- A. Precast Concrete: Air-entrained, 3500 PSI (min) compression strength at 28 days.
- B. Size: 7'-0" x 7'-0" x 4'-6" precast transformer vault or as required by Utility Company. (Verify)
- C. Provide precast transformer vault top with 4'-0" x 2'-6" cable opening in front side.
- D. Provide tongue and groove construction seals top to base.
- E. Provide 2'-8" x 5'-6" conduit knockout area on all 4 sides of vault.
- 2.8 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

2.9 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

2.10 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.
- 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.

2.11 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.

2.12 REINFORCING FOR CONCRETE ENCASEMENT

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

2.13 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.
- C. Verify transformer vault dimensions with transformer.

3.2 PREPARATION

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

3.3 DUCT BANK INSTALLATION

- A. Provide concrete encasement for primary and secondary electric duct banks.
- B. Provide concrete encasement for telecommunications and site lighting ductbanks only under paved areas. Provide stonedust encasement for all non-paved areas unless otherwise noted.
- C. Install duct to locate top of ductbank at depths as indicated on drawings, NEC and as required by project conditions.
- D. Install duct with minimum slope of 4" per 100'. Slope duct away from building entrances.

- E. Cut duct square using saw or pipe cutter; de-burr cut ends.
- F. Insert duct to shoulder of fittings; fasten securely.
- G. Join nonmetallic duct using adhesive as recommended by manufacturer.
- H. 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.
- I. Install no more than equivalent of three 90° bends between pull points.
- J. Provide suitable fittings to accommodate expansion and deflection where required.
- K. Terminate duct at manhole entries using end bell.
- L. Stagger duct joints vertically in concrete encasement 6" minimum.
- M. Use suitable separators and chairs installed not greater than 4' on centers for encased ductbanks.
- N. Securely anchor duct to prevent movement during concrete placement.
- O. Provide concrete under provisions of Division 3.
- P. Provide minimum 3" concrete cover at bottom, top, and sides of ductbank.
- Q. Connect to existing concrete encasement using dowels.
- R. Provide suitable pull string in each empty duct except sleeves and nipples.
- S. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- T. Provide backfill for all trenches under provisions of Division 31.
- U. Interface installation of underground warning tape with backfilling specified in Division 31.
- V. Provide bends in duct bank as necessary to allow conduits to enter access structures perpendicular to the structure wall.
- W. A minimum separation of 12" shall be maintained between telecommunication ductbanks and electrical ductbanks.

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 PRECAST MANHOLE INSTALLATION

- A. Install and seal precast sections in accordance with manufacturer's instructions.
- B. Install manholes plumb.
- C. Install top of manhole at least 1'-0" below finished grade. Use precast neck and shaft sections to bring manhole cover to finished elevation.
- D. Attach cable racks to inserts after manhole installation is complete.
- E. Waterproof exterior surfaces, joints, and interruptions of manholes after concrete has cured 28 days.
- F. Provide all excavation, backfill and crushed stone base required to install manhole.
- G. This contractor shall be responsible to pump out any water from manholes during the entire project.

3.7 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.

3.8 TRANSFORMER FOUNDATION INSTALLATION

- A. Install foundation no closer than 25'-0" to any building or as required by Utility Company. (Verify)

- B. Provide a minimum clearance around all four sides as follows:
 - 1. Front – 10'-0" minimum
 - 2. Back – 5'-0" minimum
 - 3. Sides – 5'-0" minimum
- C. Provide all excavation, backfill and crushed stone base required to install transformer vault.
- D. Final grade around transformer foundation shall be 3" to 6" below top of foundation surface and graded so that water drains away from the foundation.
- E. Provide ground ring and ground rods as required by Utility Company and N.E.C. requirements.
- F. Provide removable bollards on front and stationary bollards on sides and back. Spacing shall be as required to protect transformer or as required by the Utility Company.

3.9 MANHOLE, HANDHOLE & TRANSFORMER VAULT WATERPROOFING

- A. Apply two coats 2-3 mils thickness (min) of a standard asphalt or epoxy waterproofing material in complete compliance with the manufacturer's recommendations.
- B. Fill all cracks and grooves.
- C. Verify coating is free from breaks and pinholes.
- D. The coating shall completely cover all exterior surfaces of the manhole, handhole, or transformer foundation. Provide additional coating to patch all penetrations.

3.10 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.

3.11 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Manholes: Install a driven grounding rod close to wall and set rod depth so 4" will extend above finished floor. Where necessary, install grounding rod before manhole is placed and provide a #1/0 AWG bare, tinned-copper conductor from grounding rod into manhole through a waterproof sleeve in manhole wall. Protect grounding rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2" above to 6" below concrete. Seal floor opening with waterproof, non-shrink grout.
- B. Connections to Manhole Components: Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to grounding rod or grounding conductor. Make connections with minimum #4 AWG stranded, hard-drawn copper wire. Train conductors' plumb or level around corners and fasten to manhole walls.

Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

- C. 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

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.
- 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.
- 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.
 - 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.

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.
- 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.
 - 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.

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.

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

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.
- 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 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.
 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)

END OF SECTION 260553

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.
- B. Contractor for collecting information required for study and performing all field investigations as necessary to complete report.

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.

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.

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.

- 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.

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

SECTION 260583 – UTILITY SERVICE ENTRANCE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Arrangement with Utility Company for Permanent Electric Service
- B. Service Entrance as indicated on the Drawings
- C. Metering Equipment

1.2 COORDINATION

- A. The Contractor shall provide the following items in accordance with the serving electric utility company's requirements:
 - 1. Service Disconnecting Device
 - 2. Service Lug Compartments and Lugs
 - 3. Instrument Transformer Compartments or Enclosures
 - 4. Meter Sockets
 - 5. Service Trenches
 - 6. Transformer Foundations and Grounding
 - 7. Service Conduits and Ductbanks
 - 8. Service Conductors and Terminations
 - 9. Riser Conduits, Elbows, and Stand-offs
- B. Refer to Section 260010 of this specification, who is responsible for all service costs.
- C. Contractor to verify with the various Utility Company's exact location of their facilities and exact location for terminating the service conduits before starting any work and adjust as required.

1.3 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code

1.4 SYSTEM DESCRIPTION

- A. Utility Company: PECO Energy
- B. System Characteristics: As indicated on the drawings.
- C. Service Entrance: As indicated on the drawings.

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. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.

1.6 QUALITY ASSURANCE

- A. Perform work in accordance with Utility Company written requirements.
- B. Maintain one copy of each document on site.

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 shown.

1.8 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated.

PART 2 - PRODUCTS

2.1 UTILITY METERS

- A. Meters will be furnished by Utility Company.

2.2 UTILITY METER BASE

- A. Meter base will be provided by the Contractor.

2.3 METERING TRANSFORMER CABINET

- A. Manufacturers: Provided by Contractor per Utility Company approval list when applicable.

2.4 TRANSFORMER BASE

- A. Manufacturers: Provided by Contractor per Utility Company approval list.
- B. Description: Precast concrete transformer base with cable pit sized per Utility Company requirements.
- C. Installation: Provide installation of precast concrete transformer base as directed by the Utility Company.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions under provisions of Section 260010.
- B. Verify that service equipment is ready to be connected and energized.

3.2 PREPARATION

- A. Make arrangement with Utility Company to obtain permanent electric service to the Project.
- B. Coordinate location of Utility Company's facilities to ensure proper access is available.

3.3 INSTALLATION

- A. Install service entrance conduits in concrete envelope from Utility Company's terminal pole to Utility Company's pad-mounted transformer to building service entrance equipment. Utility Company will connect primary service lateral conductors to primary service entrance conductors.
- B. PECO: The Electrical Contractor shall furnish and install, via the underground ducts, the primary service conductors and make final connections at the transformer per utility company requirements.
- C. The Contractor shall also furnish and install, via the underground ducts, the secondary service conductors from the transformer to the building service equipment and make final connections at the transformer and the building service equipment.
- D. The Contractor to provide necessary primary and/or secondary lugs at transformers per utility company requirements.

END OF SECTION 260583

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.

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.

SWITCHBOARD & PANELBOARD NOTES	
1	Refer to Power Riser Diagram for wire and conduit sizes.
2	Ground fault protected breaker for equipment protection (30mA).
3	Ground fault protected breaker for personal protection (6mA).
4	Provide conductors, overcurrent device and exact placement as recommended by the TVSS manufacturer.
5	Refer to drawings for wire and conduit sizes.
6	Mark breaker red in color with handle to lock in the on position.
7	Provide breaker with permanently fastened pad lockable hasp accessory.
8	Provide 2#10 + 1#10 gnd in 3/4" conduit for voltage drop.
9	Provide an circuit breaker that delivers high levels of selective coordination circuit breaker for selective overcurrent coordination with upstream and downstream breakers. Upstream breakers shall be a minimum of one breaker frame size larger than the next downstream breaker. Breakers rated greater than 70A 2- or 3-poles shall be electronic trip with long-time (L), long-time delay, short-time (I), short-time delay and instantaneous (I) trip settings.
10	Provide new breaker in existing space provision or replace existing breaker(s) at this circuit location in panel as required for new breaker installation. Provide breaker with minimum asymmetric interrupting rating greater than or equal to the existing breakers in panel. Provide all bus extensions, filler plates and mounting equipment as needed.
11	Existing branch circuit estimated load.
12	Type E Electronic Type Breaker
13	Existing circuit breaker space provision.
14	Breaker shall be suitable for bi-directional/backfeed power.
15	Existing circuit breaker.
16	Provide Maintenance Mode Switch (MMS) and accessories as required to new or existing circuit breaker to meet NEC Arc Energy Reduction.
17	Existing breaker is turned off.
18	Electronic trip breaker with long time, long time delay, short time, short time delay, instantaneous setting adjustments. If breaker is 480 volt, unless otherwise noted, provide with ground fault setting also.
19	Tandem circuit breaker.
20	Provide two (2) #3/0-750 KCM kugs per phase and neutral.
21	Transfer load from OLA2 to ELA1 after panel ELA1 is energized.
SWITCHBOARD/DISTRIBUTION PANEL BREAKER TYPES	
AFR	Arc Flash Reduction Switch and Control / Energy Reduction Maintenance Switch (ERMS)
APS	Argos Power Supply
AUX	2 FormC Breaker Auxiliary Controls
COM	ModBus, Ethernet IP Communications
E	Electronic Trip with Long-time, Long-time Delay, Short-time, Short-time Delay, Instantaneous Setting Adjustments. If Breaker is 480 Volts, Unless Otherwise Noted, Provide with Ground-fault Settings also.
EN1	Breaker Power Supply
EP	Energy/Power Trip Unit with Long-time, Long-time Delay, Short-time, Short-time Delay, Instantaneous Settings Adjustments, Zone Selective Interlocking, Breaker Status Display & MODBUS Wired Communications. If Breaker is 480 Volts, Unless Otherwise Noted, Provide with Ground-fault Setting also.
GF	Ground Fault Protection
HC	Permanently Fastened Pad Lockable Breaker Accessory For Servicing
LI	Electronic Trip with Long-time and Instantaneous Settings Adjustments
LSI	Electronic Trip with Long-time, Short-time and Instantaneous Setting Adjustments
MCH	Spring Charging Motor
ST	Shunt Trip Breaker Accessory, 120V Unless Otherwise Noted
T	Thermal-magnetic
ZSI	Zone Selective Interlocking
100	100% Rated Circuit Breaker

EX PANEL		Bus:	125A	Additional Panel Notes: [GE A Series II] Panel Provided For Reference Only											
CP1		Main Type:		MCB 100A/3P		Existing 100% Neutral and Ground Buses									
		Volts:		208/120V, 3PH, 4W											
		Poles:		42											
		AIC:		Existing											
(DAO Office)		Mounting:		Surface		[.] denotes existing load description.									
CKT.	Breaker Amp Pole	Description		Notes	Load			Notes	Description	Breaker		CKT.			
					A	B	C			Pole	Amp				
1	20 1	[Rec - 007 & 008]		11,15	1.1	0.5			11,15	LTG - Vest.F105 Corr.F104 [Spare]		1 20 2			
3	20 1	[Rec - 002 & 003]		11,15			1.1	1.4		11,15	REC - Conf Rm F108 [Spare]		1 20 4		
5	20 1	[Rec - 003B]		11,15					0.0	11,15	[Spare]		1 20 6		
7	20 1	[Rec - 019]		11,15	0.7	0.0				11,15	[Spare]		1 20 8		
9	20 1	[Rec - 016]		11,15			0.7	0.5		11,15	[Rec - 031]		1 20 10		
11	20 1	[Rec - 020]		11,15						11,15	[Rec - Lobby TV]		1 20 12		
13	20 1	[Rec - 016]		11,15	0.7	0.7			0.2	11,15	REC - Reception F102 [Spare]		1 20 14		
15	20 1	[Rec - 020]		11,15			0.7	0.0		11,15	[Spare - On Rack]		1 20 16		
17	20 1	[Rec - 106]		11,15					0.0	11,15	[Spare - On Rack]		1 20 18		
19	20 1	[Rec - 107 & 108]		11,15	1.1	0.0				11,15	[Spare]		1 20 20		
21	20 1	[Rec - 108 & 108A]		11,15			1.1	0.5		11,15	[Security System]		1 20 22		
23	20 1	[Rec - 109 & 109A]		11,15					0.0	11,15	[Spare]		1 20 24		
25	20 1	[Rec - 118,119,120]		11,15	1.1	0.0				11,15	[Spare]		1 20 26		
27	20 1	[Rec - 121]		11,15			0.7	0.0		11,15	[Spare]		1 20 28		
29	20 1	[Rec - 122B,122C,123]		11,15					0.0	11,15	[Spare]		1 20 30		
31	20 1	[Rec - 124,124A,124B]		11,15	1.1	0.0				11,15	[Spare]		1 20 32		
33	20 1	[Rec - 104, 104A]		11,15			1.1	0.0		11,15	[Spare]		1 20 34		
35	20 1	[Rec - 103A, 103C]		11,15					0.7	11,15	[Life Skills Back Wall 006]		1 20 36		
37	20 1	[Rec - 128, 128A]		11,15	1.1	0.0				11,15	[TVSS Unit]		3 20 38		
39	20 1	[Rec - 126, 126A]		11,15			1.1	0.0		11,15			40		
41	20 1	[Rec - 124,124A, 124B]		11,15					0.0	11,15			42		
				8.1					8.9		7.4		Panel Section Connected Load: 24.4 KVA		
									Phase Totals					Panel Total Connected Load: 24.4 KVA	

EX PANEL		Bus:	100A	Additional Panel Notes: [Cutlar Hammer Pow-R-Line C Type PRL3A] Panel Provided For Reference Only										
CP-1				Main Type:		MLO		Existing 100% Neutral and Ground Buses						
				Volts:		208/120V, 3PH, 4W								
				Poles:		42								
				AIC:		Existing								
				Mounting:		Surface								
				[.] denotes existing load description.										
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.		
	Amp	Pole			A	B	C			Pole	Amp			
1	20/20	1/1	[Rec - Rm 11 / Rec - Rm 13]	11,15,19	0.7	0.5			11,15,19	[Rec - Rm 11]	1/1	20/20	2	
3	20/20	1/1	[Rec - Rm 13]	11,15,19			0.5	0.7		11,15,19	[Rec - Rm 10]	1/1	20/20	4
5	20/20	1/1	[Rec - Rm 10 / Rec - Rm 12]	11,15,19				0.7	0.5	11,15,19	[Rec - Rm 12]	1/1	20/20	6
7	20	2	[Rec - Rms 14,15]	11,15	0.7	0.5			11,15,19	[Rec - Rm 14]	1/1	20/20	8	
9			[Rec - Rm 2]				0.5	0.5	11,15,19	[Rec - Rm 15]	1/1	20/20	10	
11	20	2	[Rec - Rm 4]	11,15				0.5	0.7	11,15	[Rec - Rms 4,2]	2	20	12
13			[Rec - Rm 1]		0.5	0.7				[Rec - Rms 1,3]			14	
15	20	2	[Rec - Rm 3]	11,15			0.5	0.5		11,15	[Rec - Rm 5]	2	20	16
17			[Rec - Rm 5,7]					0.7	0.5	[Rec - Rm 7]			18	
19	20	2	[Rec - Rm 6]	11,15	0.5	0.7				11,15	[Rec - Rms 6,8]	2	20	20
21			[Rec - Rm 8]				0.5	0.7		[Split Pumps]			22	
23	20	2	[Hub (Conf Rm)]	11,15					0.0	11,15	[Spare]	2	20	24
25					0.5	0.5				[Rec - Computer Rm & Main Office]			26	
27	20/20	1/1	[Computer Rm Counter]	11,15,19			0.5	0.5		11,15	[Copy Machine Main Office]	2	20	28
29	20/20	1/1	[Computer Rm Counter]	11,15,19				0.5	0.5	[Rec - Conf Rm / Principal Office]			30	
				6.1			5.8		5.4		Panel Section Connected Load: 17.3 KVA			
							Phase Totals			Panel Total Connected Load: 17.3 KVA				

EX PANEL		Bus:	100A	Additional Panel Notes: [Cutlar Hammer Pow-R-Line C Type PRL3A] Panel Provided For Reference Only													
CP-2				Main Type:		MLO		Existing 100% Neutral and Ground Buses									
				Volts:		208/120V, 3PH, 4W											
				Poles:		30											
				AIC:		Existing											
				Mounting:		Surface											
				[.] denotes existing load description.													
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.					
	Amp	Pole			A	B	C			Pole	Amp						
1	20/20	1/1	[Rec - Rm 19 / Rec - Rm 17]	11,15,19	0.3	0.3			11,15,19	[Rec - Rm 19 / Rec - Rm 17]	1/1	20/20	2				
3	20/20	1/1	[Rec - Rms 20,22 / Rec - Rm 24]	11,15,19			1.4	1.4		[Rec - Rm 20 / Rec - Rm 16]	1/1	20/20	4				
5	20/20	1/1	[Rec - Rms 21,23 / Rec - Rm 18b]	11,15,19				0.3	0.3	[Rec - Rm 18A / Rec - Rm 18B]	2	20	6				
7	20/20	1/1	[]	11,15,19	1.4	1.4							8				
9		1	[Provision]	13			0.3	0.3		[A/C Power 126]	2	20	10				
11		1	[Provision]	13				1.4	1.4				12				
13	20	1	[A/C Power Rm 128]	11,15	0.3	0.3				[Rec - Rm 26B / Rec - Rm 26A]	1/1	20/20	14				
15	20	2	[A/C Power Rm 122]	15,17			1.4	0.5		[A/C Power 135]	2	20	16				
17									0.3	0.5			18				
19	20	1	[Rec - Rm 18A]	11,15	1.4	0.5				[A/C Power 133]	2	20	20				
21	20	1	[Rec - Rm 26A/B]	11,15			1.4	0.5					22				
23	20	1	[Projection Screen]	11,15					1.4	0.0	1	20	24				
25	20	1	[Cat Sign]	15,17	0.0	0.0				[Spare]	1	20	26				
27	20	1	[Gym Projector]	11,15			0.0	0.0		[AC Power Rm m143 / Kiln]	1/1	20/20	28				
29	20	1	[]	11,15					0.4	0.0	1/1	20/20	30				
				5.7			7.1		5.8		Panel Section Connected Load: 18.6 KVA						
							Phase Totals			Panel Total Connected Load: 18.6 KVA							

DIST. PANEL		Bus:	225A	Additional Panel Notes:									
EDP		Main Type:	200A/3P MCB Notes 7,9	100% Neutral and Ground Buses; Provide Remote or Integral Transient Voltage Surge Protection Unit L2									
		Volts:	208/120V, 3PH, 4W	BASE BID - Owner Furnished, Electrical Alternate EC-4 - Contractor Furnished									
		Poles:	30										
		AIC:	65,000										
(LIFE SAFETY)		Mounting:	Surface										
CKT.	Breaker	Description		Notes	Load			Notes	Description	Breaker		CKT.	
	Amp	Pole	A		B	C	Pole			Amp			
1	125	3	Panel ELA1	1,9	1.7	1.2		1.7	1.2		3	125	2
3													4
5								1.7	1.2				6
7	125	3	Panel ELD1	1,9	0.7	0.0		0.7	0.0		3	125	8
9													10
11									0.7	0.0			12
13	125	3	Panel ELE1	1,9	0.5	0.0					3		14
15								0.5	0.0				16
17													18
19	20	3	Provision		0.0	0.0					3	30	20
21													22
23								0.0	0.0	0.0			24
25	20	1	Battery Charger for Generator		1.0	0.0					1		26
27		1	Provision					0.0	0.0		1		28
29		1	Provision								1		30
					5.1		4.1		4.1		Panel Section Connected Load:		13.3 KVA
											Panel Total Connected Load:		13.3 KVA

PANELBOARD		Bus:	225A	Additional Panel Notes:										
ELA1		Main Type:	MLO	100% Neutral and Ground Buses										
		Volts:	208/120V, 3PH, 4W	Provide with integral transient voltage surge suppression unit Type L2										
		Poles:	30											
		AIC:	10,000											
		Mounting:	Flush											
CKT.	Breaker	Description		Notes	Load			Notes		Description	Breaker		CKT.	
Amp	Pole				A	B	C				Pole	Amp		
1	15	1	Em Ltg - Area A Corridors		0.4	1.0			7,21	FACP	1	15	2	
3	15	1	Em Ltg - A123, A124				0.1	0.9	7,21	FASEP	1	15	4	
5	15	1	Em Ltg B101,B104,B105,B108, B110,B111					0.3	0.9	7,21	FASEP	1	15	6
7	15	1	Em Ltg B106,B107		0.1					Spare	1	15	8	
9	15	1	Em Ltg B113,B124				0.3			Spare	1	15	10	
11	15	1	Em Ltg B114,B117,B118,B120					0.1	0.0	Spare	1	15	12	
13	15	1	Em Ltg B126,B127,BB131,B132,B138		0.3	0.0				Spare	1	15	14	
15	15	1	Em Ltg Exterior A/B				0.2	0.0		Spare	1	15	16	
17	15	1	Pole Ltg Egress Pathway	8				0.3	0.0	Spare	1	15	18	
19	15	1	Exit Lights A/B		0.1	0.0				Spare	1	15	20	
21		1	Provision				0.0	0.0		Provision	1		22	
23		1	Provision					0.0	0.0	Provision	1		24	
25		1	Provision		0.0	0.0				Provision	1		26	
27		1	Provision				0.0	0.0		Provision	1		28	
29		1	Provision					0.0	0.0	Provision	1		30	
					1.9	1.5		1.6	Panel Section Connected Load:		5.0 KVA			
					Phase Totals				Panel Total Connected Load:		5.0 KVA			

PANELBOARD		Bus:	225A	Additional Panel Notes:										
ELC1		Main Type:		MLO	100% Neutral and Ground Buses									
		Volts:		208/120V, 3PH, 4W	Provide with integral transient voltage surge suppression unit Type L2									
		Poles:		30										
		AIC:		10,000										
		Mounting:		Surface										
CKT.	Breaker	Description		Notes	Load			Notes	Description	Breaker		CKT.		
	Amp Pole				A	B	C			Pole	Amp			
1	15 1	Em Ltg Corridor C115,C116		0.5	0.0				Spare	1	15	2		
3	15 1	Em Ltg B121,B122				0.3	0.0		Spare	1	15	4		
5	15 1	Em Ltg B126,B127,B131,B132,B138						0.3	0.0	1	15	6		
7	15 1	Em Ltg C111,C115,C123,C126,C128		0.4	0.0				Spare	1	15	8		
9	15 1	Em Ltg Gym C124				1.2	0.0		Spare	1	15	10		
11	15 1	Em Ltg Corridor C109						0.2	0.0	1	15	12		
13	15 1	Em Ltg Exterior B/C		0.3	0.0				Spare	1	15	14		
15	15 1	Em Ltg Courtyard				0.1	0.0		Spare	1	15	16		
17	15 1	Em Ltg Platform						0.2	0.0	1	15	18		
19	15 1	Exit Lights Area B		0.1	0.0				Spare	1	15	20		
21	15 1	Exit Lights Area C				0.1	0.0		Spare	1	15	22		
23	1	Provision						0.0	0.0	1		24		
25	1	Provision		0.0	0.0				Provision	1		26		
27	1	Provision							Provision	1		28		
29	1	Provision				0.0	0.0		Provision	1		30		
				1.3			1.7		0.7		Panel Section Connected Load: 3.6 KVA			
							Phase Totals				Panel Total Connected Load: 3.6 KVA			

PANELBOARD			Bus:	225A	Additional Panel Notes:								
ELD1			Main Type:		MLO	100% Neutral and Ground Buses							
			Volts:		208/120V, 3PH, 4W	Provide with integral transient voltage surge suppression unit Type L2							
			Poles:		30								
			AIC:		10,000								
			Mounting:		Surface								
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.	
	Amp	Pole			A	B	C			Pole	Amp		
1	15	1	Em Ltg Area D		0.8	0.9				FASEP	1	15	2
3	15	1	Exit Signs Area D				0.1	0.0		Spare	1	15	4
5	15	1	Em Ltg Exterior D					0.1	0.0	Spare	1	15	6
7	15	1	Spare		0.1	0.0				Spare	1	15	8
9	15	1	Pole Ltg Egress Pathway	8			0.2	0.0		Spare	1	15	10
11	15	1	Spare					0.0	0.0	Spare	1	15	12
13	15	1	Spare		0.0	0.0				Spare	1	15	14
15	15	1	Spare				0.0	0.0		Spare	1	15	16
17	15	1	Spare					0.0	0.0	Spare	1	15	18
19		1	Provision		0.0	0.0				Provision	1		20
21		1	Provision				0.0	0.0		Provision	1		22
23		1	Provision					0.0	0.0	Provision	1		24
25		1	Provision		0.0	0.0				Provision	1		26
27		1	Provision				0.0	0.0		Provision	1		28
29		1	Provision					0.0	0.0	Provision	1		30
					1.8		0.3	0.1	Panel Section Connected Load: 2.1 KVA				
					Phase Totals					Panel Total Connected Load: 2.1 KVA			

PANELBOARD			Bus:	225A	Additional Panel Notes:										
ELE1			Main Type:		MLO	100% Neutral and Ground Buses									
			Volts:		208/120V, 3PH, 4W	Provide with integral transient voltage surge suppression unit Type L2									
			Poles:		30										
			AIC:		10,000										
			Mounting:		Surface										
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.			
	Amp	Pole			A	B	C			Pole	Amp				
1	15	1	Exit Signs Area E		0.1	0.9			7	FASEP	1	15	2		
3	15	1	Em Lighting Area E				0.5	0.0		Spare	1	15	4		
5	15	1	Em Ltg Exterior E					0.1	0.0	Spare	1	15	6		
7	15	1	Spare		0.0	0.0				Spare	1	15	8		
9	15	1	Spare				0.0	0.0		Spare	1	15	10		
11	15	1	Spare					0.0	0.0	Spare	1	15	12		
13	15	1	Spare		0.0	0.0				Spare	1	15	14		
15	15	1	Spare				0.0	0.0		Spare	1	15	16		
17	15	1	Spare					0.0	0.0	Spare	1	15	18		
19		1	Provision		0.0	0.0				Provision	1		20		
21		1	Provision				0.0	0.0		Provision	1		22		
23		1	Provision					0.0	0.0	Provision	1		24		
25		1	Provision		0.0	0.0				Provision	1		26		
27		1	Provision				0.0	0.0		Provision	1		28		
29		1	Provision					0.0	0.0	Provision	1		30		
					1.0		0.5		0.1		Panel Section Connected Load: 1.6 KVA				
					Phase Totals								Panel Total Connected Load: 1.6 KVA		

EX PANEL		Bus:	225A	Additional Panel Notes: [Westinghouse Pow-R-Line C] Panel Provided For Reference Only															
EP				Main Type:		MLO		Existing 100% Neutral and Ground Buses											
				Volts:		208/120V , 3PH, 4W													
				Poles:		42													
				AIC:		Existing													
				Mounting:		Surface													
				[.] denotes existing load description.															
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.							
	Amp	Pole			A	B	C			Pole	Amp								
1	90	3	[HWP #2]	11,15	5.8	5.8		11,15	[HWP #1]	3	90	2							
3							5.8					4							
5								5.8	5.8			6							
7	20	1	[Batt. Charger on Generator]	11,15	0.2	0.3			[Emer. Ltg - Café & Corr. Bldg #1]	1	20	8							
9	20	1	[Generator Fuel Pump]	11,15			0.5	0.3	[Emer. Exit Ltg Bldg #1]	1	20	10							
11	20	1	[Bath Rm Ltg & Rec -Nurse OFC]	11,15				0.5	0.8	[Emer. Aud.,Lobby & Vest. Bldg #1]	1	20	12						
13	20	1	[Fire Alarm System]	11,15	0.5	0.5			[Emer. Fix. Outside Doors Bldg #1]	1	20	14							
15	20	1	[Admin./Faculty Suite Ltg]	11,15			0.8	0.5	[Camera System Rm 116 Closet]	1	20	16							
17	20	1	[Emer. &Exit Lites,New Gym,Data-Trailer]	11,15				0.5	0.3	[Boiler Rm Ltg & Exit Signs]	1	20	18						
19	20	1	[Emer. & Exit Lites Bldg #2]	11,15	0.5	0.5			[Burgular Alarm]	1	20	20							
21	20	1	[Outdoor & Vest. Ltg Bldg #2 Emer. Ltg]	11,15			0.5	0.8	[Boiler #1]	1	20	22							
23	20	1	[Outdoor & Vest. Ltg Bldg #1]	11,15					[Boiler #2]	1	20	24							
25	20	1	[Emer. & Exit Lites Bldg #3]	11,15	0.5	0.7			[Hot Water Ckt]	1	20	26							
27	20	1	[Outdoor & Vest. Ltg Bldg #3]	11,15			0.5	0.5	[Emer. Ltg & Exit Signs - Café.]	1	20	28							
29	20	1	[Rec - Air Dryer]	11,15					[New Sound System]	1	20	30							
31	20	1	[Ltg - Corr. Exist. Bldg]	11,15	0.5	0.5			[New Sound System]	1	20	32							
33	20	1	[Ltg - Library Bldg #1]	11,15			0.5	1.0	[Rec - Ice Cream Cab.]	1	20	34							
35	20	1	[Heat Trace]	11,15				0.0	1.0	[Rec - Kitchen Refrig.]	1	20	36						
37	20	1	[METASYS]	11,15	0.0	1.0			[Rec - Refrig & Freezer]	1	20	38							
39	20	1	[Spare]	11,15			0.0	0.4	[Rec - Telephone Office]	1	20	40							
41		1	[Provision]	13				0.0	0.5	[Rec - Data 140/113]	1	20	42						
				17.3					17.6		17.4			Panel Section Connected Load: 52.3 KVA					
									Phase Totals					Panel Total Connected Load: 52.3 KVA					

EX PANEL		Bus:	225A	Additional Panel Notes: [Eaton Type PRL1A] Panel Provided For Reference Only												
FR				Main Type:		MLO	Existing 100% Neutral and Ground Buses									
				Volts:		208/120V , 3PH, 4W										
				Poles:		42										
				AIC:		Existing										
		Mounting:		Surface	[.] denotes existing load description.											
CKT.	Breaker		Description		Notes	Load			Notes	Description	Breaker		CKT.			
	Amp	Pole				A	B	C			Pole	Amp				
1	20	1	[Copy Machine]		11,15	0.7	0.5			11,15	[Rec - Faculty by Sink]	1	20	2		
3	20	1	[Rec - Faculty]		11,15			0.5	0.7		[Rec - Faculty]	1	20	4		
5	20	2	[]		11,15					0.7	0.5		2	20	6	
7						0.7	0.5							8		
9	20	2	[A/C - Rm 100]		11,15			0.5	0.5				2	20	10	
11														12		
13	20	1	[Spare]		15,17	0.0	0.7						2	20	14	
15	20	1	[Spare]		15,17										16	
17	20	1	[Spare]		15,17				0.0	0.0		[A/C - Principiplay Office]	2	20	18	
19	20	1	[Spare]		15,17	0.0	0.0								20	
21	20	1	[Spare]		15,17			0.0	0.0			[Spare]	1	20	22	
23	20	1	[Spare]		15,17					0.0	0.0	[Spare]	1	20	24	
25	20	1	[Spare]		15,17	0.0	0.0					[Spare]	1	20	26	
27	20	1	[Spare]		15,17			0.0	0.0			[Spare]	1	20	28	
29	20	1	[Spare]		15,17					0.0	0.0	[Spare]	1	20	30	
31		1	[Provision]		13	0.0	0.0				[Provision]	1			32	
33		1	[Provision]		13			0.0	0.0			[Provision]	1		34	
35		1	[Provision]		13					0.0	0.0	[Provision]	1		36	
37		1	[Provision]		13	0.0	0.0					[Provision]	1		38	
39		1	[Provision]		13							[Provision]	1		40	
41		1	[Provision]		13				0.0	0.0		[Provision]	1		42	
						3.2		2.9		2.5		Panel Section Connected Load: 8.6 KVA				
						Phase Totals					Panel Total Connected Load: 8.6 KVA					

EX PANEL		Bus:	125A	Additional Panel Notes: [Eaton Type PRL1A] Panel Provided For Reference Only											
H1A		Main Type:		MCB 125A/3P		Existing 100% Neutral and Ground Buses									
		Volts:		480/208V , 3PH, 4W											
		Poles:		42											
		AIC:		22,000											
(DAO Office)		Mounting:		Surface		[] denotes existing load description.									
CKT.	Breaker	Description		Notes	Load			Notes	Description	Breaker		CKT.			
					A	B	C						Pole	Amp	
1	20	1	[Lights]	11,15	1.0	1.0		11,15	[Lights]	1	20	2			
3	20	1	[LTG - Corridor]	11,15		1.0	1.0	11,15	[Lights]	1	20	4			
5	20	1	[Lights]	11,15			1.0	11,15	[Outside Lights Timer]	1	20	6			
7	20	1	[Spare]	15,17	0.0	1.0		11,15	[Outside Parking Lights]	1	20	8			
9	20	1	[Spare]	15,17		0.0	0.0	11,15	[Spare (Blue) JB Above]	1	20	10			
11	20	1	[Spare]	15,17			0.0	15,17	[Spare]	1	20	12			
13	40	3	[AHU-2]	11,15	0.0	0.0		15,17	[Spare]	3	20	14			
15						0.0	0.0					16			
17							0.0	0.0				18			
19	20	3	[RF-2]	11,15	0.0	0.0		15,17	[Spare]	3	20	20			
21						0.0	0.0					22			
23							0.0	0.0				24			
25	20	3	[Spare]	15,17	0.0	0.0		15,17	[Spare]	3	20	26			
27						0.0	0.0					28			
29							0.0	0.0				30			
31	20	3	[Spare]	15,17	0.0	0.0		15,17	[Spare]	3		32			
33						0.0	0.0					34			
35							0.0	0.0				36			
37	20	3	[Spare]	15,17	0.0	0.0	0.0	15,17	[Spare]	3		38			
39							0.0					40			
41					3.0		0.0	0.0				42			
					2.0			2.0	Panel Section Connected Load: 7.0 KVA						
					Phase Totals				Panel Total Connected Load: 7.0 KVA						

PANEL		Bus:	800A	Additional Panel Notes:										
HPV		Main Type:		MLO	100% Neutral and Ground Buses. Provide integral transient voltage surge suppression unit Type H2.									
		Volts:		480/277V, 3PH, 4W	Provide NEMA 3R panelboard enclosure.									
		Poles:		24										
		AIC:		10,000										
		Mounting:		Surface										
CKT.	Breaker	Description		Notes	Load			Notes	Description	Breaker		CKT.		
		Amp	Pole		A	B	C			Pole	Amp			
1	125	3	Photovoltaic Inverter A (Inverter Max. Output Current = 72.2A)	1,14	20.0	13.0		1,14	Photovoltaic Inverter B (Inverter Max. Output Current = 43.5A)	3	60	2		
3						20.0	13.0					4		
5							20.0	13.0				6		
7	60	3	Photovoltaic Inverter C (Inverter Max. Output Current = 43.5A)	1,14	13.0	0.0		1,14	Spare	3	125	8		
9						13.0	0.0					10		
11							13.0	0.0				12		
13		3	Provision		0.0	0.0			Provision	3		14		
15						0.0	0.0					16		
17							0.0	0.0				18		
19		3	Provision		0.0	0.0		4	Transient Voltage Surge Suppression Unit Type L2	3	60	20		
21						0.0	0.0					22		
23							0.0	0.0				24		
					46.0		46.0		Panel Section Connected Load:	138.0 KVA				
					Phase Totals				Panel Total Connected Load:	138.0 KVA				

EX PANEL		Bus:	100A	Additional Panel Notes: [Cutlar Hammer Pow-R-Line C Type PRL1A] Panel Provided For Reference Only												
KP				Main Type:		MLO	Existing 100% Neutral and Ground Buses									
				Volts:		208/120V, 3PH, 4W										
				Poles:		30										
				AIC:		Existing										
				Mounting:		Flush	[.] denotes existing load description.									
CKT.	Breaker Amp	Pole	Description		Notes	Load			Notes	Description	Breaker Pole Amp		CKT.			
1	20	3	[Hood]		11,15	1.0	1.2			11,15	[Rec - Microwave]		1 20 2			
3								1.0	1.5	11,15	[Oven]		1 20 4			
5									1.0	11,15	[Rec - Stand-up Freezer by Window]		1 20 6			
7	20	1	[Rec - U/C Refrig.]		11,15	1.0	0.8			11,15	[Exhaust Fan, Bath, Trash]		1 20 8			
9	20	1	[Rec - Kitchen - Oven]		11,15			0.4	1.2	11,15	[Ltg - Bathroom, Heater]		1 20 10			
11	20	1	[Rec - Kitchen]		11,15					11,15	[Heat Over Fridge]		1 20 12			
13	20	1	[Rec - Ice Cream Freezer]		11,15	1.0	1.3			15	[Garbage Disposal]		2 20 14			
15	30	3	[Steam Tray]		11,15			1.0	1.3				16			
17													18			
19						1.0	0.5			11,15,19	[Rec - Countertop]		1/1 20/20 20			
21	60	3	[Dishwasher]		11,15			3.8	0.4	11,15	[Rec - Countertop]		2 20 22			
23													24			
25						3.8	0.4			11,15	[Rec - Cash Register]		1 15 26			
27	20	1	[Spare]		15			0.0	0.0	15	[Spare]		1 15 28			
29	20	1	[Spare]		15					11,15	[Rec - Microwave]		1 15 30			
						11.9			10.6		11.2		Panel Section Connected Load: 33.7 KVA			
						Phase Totals								Panel Total Connected Load: 33.7 KVA		

PANELBOARD		Bus:	225A	Additional Panel Notes:									
LA1		Main Type:	MLO w/ SFL	100% Neutral and Ground Buses									
		Volts:	208/120V, 3PH, 4W	Provide with sub-feed lugs.									
		Poles:	42										
		AIC:	10,000										
Section 1 of 2		Mounting:	Flush										
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes		Description	Breaker		CKT.
					A	B	C				Pole	Amp	
1	20	1	Lighting Area A Corridors		0.7	1.0			3	Receptacle WC B114	1	20	2
3	20	1	Lighting B106, B107			0.1	1.0		3	Receptacle U/C Fridge B118	1	20	4
5	20	1	Lighting B112,B113,B124				0.5	0.7		Receptacles B118,B120	1	20	6
7	20	1	Lighting B126		0.1	1.0				Receptacle Vending	1	20	8
9	20	1	Lighting B114-B116, B119			0.3	1.0			Receptacle Vending	1	20	10
11	20	1	Receptacles A105 N				0.7	1.0		Receptacle Vending	1	20	12
13	20	1	Receptacles A105 S		1.1	0.7				Receptacles B119	1	20	14
15	20	1	Receptacles A115,A116			1.1	1.0			Receptacle Microwave B119	1	20	16
17	20	1	Receptacle WC A108	3			1.0	1.0		Receptacle Microwave B119	1	20	18
19	20	1	Receptacles A114, A114A		0.7	1.0				Receptacle Microwave B119	1	20	20
21	20	1	Receptacles A114 W			0.9	0.2			Receptacle Counter B119	1	20	22
23	20	1	Receptacles A114 S				0.5	0.2		Receptacle Counter B119	1	20	24
25	20	1	Receptacles A118 N		0.9	0.2				Receptacle B115	1	20	26
27	20	1	Receptacles A118 W			0.4	2.5			30A Receptacle B115	2	30	28
29	20	1	Receptacles A118 S				0.7	2.5					30
31	20	1	Receptacles A119,A121		0.5	0.4				Receptacles Display Cases	1	20	32
33	20	1	Receptacles A123,A124			0.7	0.2			Receptacles Roof	1	20	34
35	60	3	Kiln A119				4.5	0.1		Lighting Exterior Area A/B	1	20	36
37					4.5	1.2				Motorized Shades A114, A118	1	20	38
39						4.5	0.6		8	Ltg Site Poles	1	20	40
41	20	1	Receptacles B114,B115,B116				0.7	0.1		(E) EF	1	20	42
					13.9	14.4	14.2			Panel Section Connected Load:	42.6 KVA		
					Phase Totals					Panel Total Connected Load:	55.2 KVA		

PANELBOARD		Bus:	225A	Additional Panel Notes:										
LA1		Main Type:		MLO	100% Neutral and Ground Buses									
		Volts:		208/120V , 3PH, 4W										
		Poles:		42+42										
		AIC:		10,000										
Section 2 of 2		Mounting:		Flush										
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes	Description	Breaker		CKT.		
					A	B	C			Pole	Amp			
43	20	1	Receptacles A101 S		0.9	1.1			Receptacles A104 S	1	20	44		
45	20	1	Receptacles A102 S				0.9	1.1	Receptacles A109 N	1	20	46		
47	20	1	Receptacles A103 S						Receptacles A110 W	1	20	48		
49	15	1	UV-2 A105		1.3	0.9			Receptacles A111 W	1	20	50		
51	15	1	FCU-42 A114						Receptacles A112 N	1	20	52		
53	15	1	A121 Spray Booth						Receptacles A113 N	1	20	54		
55	20	1	CUH-1(7), CUH-1(8)		0.2				Spare	1	20	56		
57	15	1	(E) UV-1 B119				0.1		Spare	1	20	58		
59	20	1	(E) CUH-37 (2) A108					0.2	Spare	1	20	60		
61	15	1	EF(E)		0.1				Spare	1	20	62		
63	20	1	Spare						Spare	1	20	64		
65	20	1	Spare						Spare	1	20	66		
67	20	1	Spare						Spare	1	20	68		
69	20	1	Spare						Spare	1	20	70		
71	20	1	Spare						Spare	1	20	72		
73	20	1	Spare						Spare	1	20	74		
75	20	1	Spare						Spare	1	20	76		
77	20	1	Spare						Spare	1	20	78		
79	20	1	Spare	3					Spare	1	20	80		
81	20	1	Spare	3					Spare	1	20	82		
83	20	1	Spare	3					Spare	1	20	84		
					4.5			4.3	3.9	Panel Section Connected Load: 12.6 KVA				
								Phase Totals			Panel Total Connected Load: 55.2 KVA			

PANELBOARD		Bus:	225A	Additional Panel Notes: 100% Neutral and Ground Buses										
LA2		Main Type:		MLO										
		Volts:		208/120V , 3PH, 4W										
		Poles:		42										
		AIC:		10,000										
		Mounting:		Flush										
CKT.	Breaker Amp Pole	Description		Notes	Load			Notes	Description	Breaker		CKT.		
1	20 1	Lighting A101			A	B	C		Receptacles A103, A103A	Pole	Amp	2		
3	20 1	Lighting A102				0.8	0.5		Receptacles A104 A104A W	1	20	4		
5	20 1	Lighting A103						0.8	(E) FCU-36 A104	1	15	6		
7	20 1	Lighting A104			0.8	0.9			Receptacles A104 N	1	20	8		
9	20 1	Lighting A109				0.8	0.9		(E) FCU-35 A113	1	15	10		
11	20 1	Lighting A110, A111						0.6	Receptacles A113 S	1	20	12		
13	20 1	Lighting A112			0.8	1.3			(E) FCU-29 A109	1	15	14		
15	20 1	Lighting A113					0.8	0.9	Receptacles A109 E	1	20	16		
17	20 1	Lighting A114						0.4	Receptacles A109 S	1	20	18		
19	20 1	Lighting A105			0.6	0.9			Receptacles A110 E	1	20	20		
21	20 1	Lighting A118					0.2	0.7	(E) FCU-38 A110	1	15	22		
23	20 1	Lighting A121, A122						0.2	(E) FCU-39 A111	1	15	24		
25	20 1	Lighting A123,A124			0.1	0.9			Receptacles A111 E	1	20	26		
27	20 1	Receptacles A101 N					0.7	1.3	(E) FCU-33 A112	1	15	28		
29	15 1	(E) FCU-30 A101						1.3	Receptacles A112A, A113A	1	20	30		
31	20 1	Receptacles A101 E			0.5	0.7			Receptacles A112 S	1	20	32		
33	20 1	Receptacles A102 W					0.5	0.4	Receptacles Roof	1	20	34		
35	20 1	Receptacles A102 N						0.7	EF-3	1	15	36		
37	15 1	(E) FCU-32 A102			1.3	0.2			EF-4	1	15	38		
39	15 1	(E) FCU-34 A103					1.3	0.0	Spare	1	20	40		
41	20 1	Receptacles A103 N						0.7	Spare	1	20	42		
					10.3	9.7	9.8		Panel Section Connected Load:	29.8 KVA				
					Phase Totals				Panel Total Connected Load:	29.8 KVA				

PANELBOARD			Bus:	225A	Additional Panel Notes:										
LB1			Main Type:		MLO	100% Neutral and Ground Buses									
			Volts:		208/120V , 3PH, 4W										
			Poles:		42										
			AIC:		65,000										
			Mounting:		Surface										
CKT.	Breaker Amp	Pole	Description		Notes	Load				Notes	Description	Breaker		CKT.	
1	20	2	EUH-1			1.5	2.5				(E) AUH-3 B130	3	35	2	
3								1.5	2.5					4	
5	20	1	Receptacles B129,B130,Exterior							0.9	2.5			6	
7	20	1	Spare									1	20	8	
9	20	1	Spare					0.0	0.0			1	20	10	
11	20	1	Spare							0.0	0.0	1	20	12	
13	20	1	Spare			0.0	0.0					1	20	14	
15	20	1	Spare					0.0	0.0			1	20	16	
17	20	1	Spare							0.0	0.0	1	20	18	
19	20	1	Spare			0.0	0.0					1	20	20	
21	20	1	Spare					0.0	0.0			1	20	22	
23	20	1	Spare							0.0	0.0	1	20	24	
25	20	1	Spare		3	0.0	0.0					1	20	26	
27	20	1	Spare		3			0.0	0.0			1	20	28	
29	20	1	Spare		3					0.0	0.0	1	20	30	
31		1	Provision			0.0	0.0				Provision	1		32	
33		1	Provision					0.0	0.0			1		34	
35		1	Provision							0.0	0.0	1		36	
37		1	Provision			0.0	0.0					1		38	
39		1	Provision									1		40	
41		1	Provision							0.0	0.0	1		42	
						4.0		4.0		3.4	Panel Section Connected Load: 11.4 KVA				
						Phase Totals						Panel Total Connected Load: 11.4 KVA			

PANELBOARD		Bus:	225A	Additional Panel Notes:									
LB2		Main Type:	MLO w/ SFL	100% Neutral and Ground Buses; Provide Sub-Feed Lugs (SFL)									
		Volts:	208/120V, 3PH, 4W										
		Poles:	42+42										
		AIC:	65,000										
Section 1 of 2		Mounting:	Flush										
CKT.	Breaker	Description		Notes	Load			Notes	Description	Breaker		CKT.	
	Amp	Pole	A		B	C	Pole			Amp			
1	20	1	Lighting B121,B122		0.7	0.9			RTU-2	3	15	2	
3	20	1	Lighting B121 Pendants				0.9	0.9				4	
5	20	1	Lighting B125, B126,B127					0.4	0.9			6	
7	20	1	Lighting B123		0.7	0.7				3	15	8	
9	20	1	Receptacles B121 N				0.9	0.7				10	
11	20	1	Receptacles B121 W					0.5	0.7			12	
13	20	1	Receptacles B121 Desks		0.7	0.5			Receptacles Roof	1	20	14	
15	20	1	Receptacles B121 E				0.5	1.0	Projector B121	1	20	16	
17	20	1	Receptacle Projector B121					1.0	0.7	Receptacles B112,B123	1	20	18
19	20	1	Receptacles B121, B122		0.7	0.7				(E) FCU-19 B125	1	15	20
21	20	1	Receptacles B122,B123				1.1	0.7		(E) FCU-14 B126	1	15	22
23	20	1	Projection Screen B123							(E) AHU-3 B130	3	35	24
25	20	1	Receptacle Projector B123		1.0	2.5			2.5			26	
27	20	1	Receptacles B123 S,W				1.3	2.5				28	
29	20	1	Receptacle WC B123					1.0	0.1	Lighting Exterior B/C	1	20	30
31	20	1	Receptacles B123,B124		0.4	1.5				Generator Block Heater	1	20	32
33	20	1	Receptacles B126 W, Exterior				0.7	0.0		Spare	1	20	34
35	20	1	Receptacles B125,B126					1.1	0.0	Spare	1	20	36
37	20	1	Receptacles B125, B127		0.5	0.0				Spare	1	20	38
39	20	1	CUH-1(7), CUH-1(8)				0.2	0.0		Spare	1	20	40
41	20	1	CUH-1(12, CUH-1(13 B124					0.1	0.0	Spare	1	20	42
					11.5		11.4	9.9	Panel Section Connected Load:	32.8 KVA			
					Phase Totals				Panel Total Connected Load:	32.8 KVA			

PANELBOARD			Bus:	225A	Additional Panel Notes:										
LB2			Main Type:		MLO	100% Neutral and Ground Buses									
			Volts:		208/120V , 3PH, 4W										
			Poles:		42+42										
			AIC:		65,000										
Section 2 of 2			Mounting:		Flush										
CKT.	Breaker	Amp	Pole	Description	Notes	Load			Notes	Description	Breaker		CKT.		
						A	B	C			Pole	Amp			
43	20	1		Spare		0.0	0.0				Spare	1	20	44	
45	20	1		Spare				0.0	0.0		Spare	1	20	46	
47	20	1		Spare					0.0	0.0	Spare	1	20	48	
49	20	1		Spare		0.0	0.0				Spare	1	20	50	
51	20	1		Spare				0.0	0.0		Spare	1	20	52	
53	20	1		Spare					0.0	0.0	Spare	1	20	54	
55	20	1		Spare		0.0	0.0				Spare	1	20	56	
57	20	1		Spare				0.0	0.0		Spare	1	20	58	
59	20	1		Spare					0.0	0.0	Spare	1	20	60	
61	20	1		Spare	3	0.0	0.0				Spare	1	20	62	
63	20	1		Spare	3			0.0	0.0		Spare	1	20	64	
65	20	1		Spare	3				0.0	0.0	Spare	1	20	66	
67		1		Provision		0.0	0.0				Provision	1		68	
69		1		Provision				0.0	0.0		Provision	1		70	
71		1		Provision					0.0	0.0	Provision	1		72	
73		1		Provision		0.0	0.0				Provision	1		74	
75		1		Provision				0.0	0.0		Provision	1		76	
77		1		Provision					0.0	0.0	Provision	1		78	
79		1		Provision		0.0	0.0				Provision	1		80	
81		1		Provision				0.0	0.0		Provision	1		82	
83		1		Provision					0.0	0.0	Provision	1		84	
						0.0		0.0		0.0		Panel Section Connected Load: 0.0 KVA			
						Phase Totals					Panel Total Connected Load: 32.8 KVA				

PANELBOARD		Bus:	250A	Additional Panel Notes:										
LC1		Main Type:	MLO w/ SFL	100% Neutral and Ground Buses; Provide Sub-Feed Lugs (SFL)										
		Volts:	208/120V, 3PH, 4W											
		Poles:	42+42											
		AIC:	10,000											
Section 1 of 2		Mounting:	Flush											
CKT.	Breaker	Description		Notes	Load			Notes	Description	Breaker		CKT.		
	Amp	Pole	A		B	C	Pole			Amp				
1	20	1	Lighting C124		1.6	1.1				Receptacles C127	1	20	2	
3	20	1	Lighting C124				1.6	0.7		Receptacles C125	1	20	4	
5	20	1	Lighting C124						0.8	0.9	Receptacles C114 E	1	20	6
7	20	1	Lighting C110,C111,C112		0.6	0.5				Receptacles C114 N	1	20	8	
9	20	1	Lighting C129				0.5	0.9		Receptacles C114 W,S,Exterior	1	20	10	
11	20	1	Lighting C114						0.5	1.0	Projection Screen C129	1	20	12
13	20	1	Lighting C115,C128		0.1	0.4				Receptacles C129 S	1	20	14	
15	20	1	Lighting C123,C125,C126,C127				0.6	0.9		Receptacles C129 N	1	20	16	
17	20	1	Lighting C117-C122						0.5	1.0	Projection Screen C113	1	20	18
19	20	1	Circuit C111		0.0	0.5				Receptacles C113 N	1	20	20	
21	20	1	Receptacles C112 N,W				0.7	1.1		Receptacles C113 S	1	20	22	
23	20	1	Receptacles C112 S,W						0.9	0.2	Receptacles Roof	1	20	24
25	20	1	Receptacles C112 E		0.7	2.5				Receptacle Dryer C120	2	30	26	
27	20	1	Receptacle WC C124	3			1.0	2.5					28	
29	20	1	Receptacle WC C124	3					1.0	1.0	Receptacle Washer C120	1	20	30
31	20	1	Receptacles C117,C118		0.7	0.1					(E) CUH C128	1	15	32
33	20	1	Receptacle WC C116	3			1.0	0.1			(E) CUH C115	1	15	34
35	20	1	Receptacles C116,C119,C120						1.3	1.3	(E) FCU-18 C114	1	15	36
37	20	1	Receptacles C121,C123		0.9	0.7					(E) FCU-38 C129	1	15	38
39	20	1	Receptacles C124 W				0.5	0.7			(E) FCU-44 C113	1	15	40
41	20	1	Receptacles C124 S						0.7	1.3	(E) FCU-16 C112	1	15	42
					10.4		12.8	12.3		Panel Section Connected Load:	35.5 KVA			
					Phase Totals					Panel Total Connected Load:	69.7 KVA			

PANELBOARD		Bus:	250A	Additional Panel Notes:										
LC1		Main Type:		MLO	100% Neutral and Ground Buses									
		Volts:		208/120V , 3PH, 4W										
		Poles:		42+42										
		AIC:		10,000										
Section 2 of 2		Mounting:		Flush										
CKT.	Breaker Amp Pole	Description		Notes	Load			Notes	Description	Breaker		CKT.		
43	15 1	(E) FCU-15 C111			A	B	C		(E) AHU-1	Pole	Amp	44		
45	20 1	Theatrical Relay Panel				1.0	4.6			3	60	46		
47	20 1	Receptacle AV Cabinet C112						1.0	4.6			48		
49	20 1	Receptacle AV Cabinet C113			1.0	4.6			(E) AHU-2	3	60	50		
51	20 1	Receptacle AV Cabinet C129				1.0	4.6					52		
53	20 1	(E) EF					0.1	4.6				54		
55	20 1	Spare			0.0	0.6			(E) EF Mezz	3	15	56		
57	20 1	Spare				0.0	0.6					58		
59	20 1	Spare					0.0	0.6				60		
61	20 1	Spare			0.0	0.0			Spare	1	20	62		
63	20 1	Spare				0.0	0.0		Spare	1	20	64		
65	20 1	Spare					0.0	0.0	Spare	1	20	66		
67	20 1	Spare			0.0	0.0			Spare	1	20	68		
69	20 1	Spare				0.0	0.0		Spare	1	20	70		
71	20 1	Spare					0.0	0.0	Spare	1	20	72		
73	20 1	Spare		3	0.0	0.0			Spare	1	20	74		
75	20 1	Spare		3		0.0	0.0		Spare	1	20	76		
77	20 1	Spare		3			0.0	0.0	Spare	1	20	78		
79		Provision			0.0	0.0			Provision	1		80		
81		Provision				0.0	0.0		Provision	1		82		
83		Provision					0.0	0.0	Provision	1		84		
					11.5	11.8	10.9		Panel Section Connected Load:	34.2 KVA				
					Phase Totals				Panel Total Connected Load:	69.7 KVA				

PANELBOARD		Bus:	225A	Additional Panel Notes:									
LC2		Main Type:	MLO w/ SFL	100% Neutral and Ground Buses; Provide Sub-Feed Lugs (SFL)									
		Volts:	208/120V, 3PH, 4W										
		Poles:	42+42										
		AIC:	10,000										
Section 1 of 2		Mounting:	Flush										
CKT.	Breaker	Description		Notes	Load			Notes	Description	Breaker		CKT.	
	Amp	Pole	A		B	C	Pole			Amp			
1	20	1	Lighting C101,C103		0.5	0.9			Receptacles C106 W	1	20	2	
3	20	1	Lighting C105				0.5	0.7	Receptacles C106 N,E	1	15	4	
5	20	1	Lighting C107					0.5	Spare	1	20	6	
7	20	1	Lighting C102,C104		0.5	0.9			Receptacles C108 W	1	20	8	
9	20	1	Lighting C106				0.5	0.7	Receptacles C108 S,E	1	20	10	
11	20	1	Lighting C108					0.5	Receptacles C107 E	1	20	12	
13	20	1	Lighting Corridor C109		0.5	0.9			Receptacles C107 S,W	1	20	14	
15	20	1	Receptacles C101 W				0.4	0.0	Spare	1	20	16	
17	20	1	Receptacles C101 E					0.4	Receptacles Roof	1	20	18	
19	20	1	Receptacles C101 S		0.9	1.3			(E) FCU-23 C107	1	20	20	
21	20	1	Receptacles C103 N				0.9	0.7	(E) FCU-27 C103	1	20	22	
23	20	1	Receptacles C103 W					0.4	(E) FCU-24 C105	1	20	24	
25	20	1	Receptacles C103 S		0.4	1.3			(E) FCU-23 C107	1	20	26	
27	20	1	Receptacles C105 E, N				0.9	1.3	(E) FCU-20 C108	1	20	28	
29	20	1	Spare						(E) FCU-21 C106	1	20	30	
31	20	1	Receptacles C105 E		0.5	0.7			(E) FCU-11 C104	1	20	32	
33	20	1	Receptacles C102 N, E				0.7	0.7	(E) FCU-10 C102	1	20	34	
35	20	1	Receptacles C102 S					0.7	(E) FCU-41 C109	1	20	36	
37	20	1	Receptacles C104 N		0.9	0.0			(E) CUH C109	1	20	38	
39	20	1	Receptacles C104 S,E				0.7	0.0	(E) F3 C109	1	20	40	
41	20	1	FCU-43 C101					0.7	Lighting Courtyard	1	20	42	
					10.0	8.6		6.9	Panel Section Connected Load:	25.6 KVA			
					Phase Totals				Panel Total Connected Load:	25.6 KVA			

PANELBOARD			Bus:	225A	Additional Panel Notes: 100% Neutral and Ground Buses										
LC2			Main Type:		MLO										
			Volts:		208/120V, 3PH, 4W										
			Poles:		42+42										
			AIC:		10,000										
Section 2 of 2			Mounting:		Flush										
CKT.	Breaker	Amp	Pole	Description	Notes	Load			Notes	Description	Breaker		CKT.		
						A	B	C			Pole	Amp			
43	20	1		Spare						Spare	1	20	44		
45	20	1		Spare						Spare	1	20	46		
47	20	1		Spare						Spare	1	20	48		
49	20	1		Spare						Spare	1	20	50		
51	20	1		Spare						Spare	1	20	52		
53	20	1		Spare						Spare	1	20	54		
55	20	1		Spare						Spare	1	20	56		
57	20	1		Spare						Spare	1	20	58		
59	20	1		Spare						Spare	1	20	60		
61	20	1		Spare	3					Spare	1	20	62		
63	20	1		Spare	3					Spare	1	20	64		
65	20	1		Spare	3					Spare	1	20	66		
67		1		Provision						Provision	1		68		
69		1		Provision						Provision	1		70		
71		1		Provision						Provision	1		72		
73		1		Provision						Provision	1		74		
75		1		Provision						Provision	1		76		
77		1		Provision						Provision	1		78		
79		1		Provision						Provision	1		80		
81		1		Provision						Provision	1		82		
83		1		Provision						Provision	1		84		
						0.0	0.0	0.0	Panel Section Connected Load: 0.0 KVA						
						Phase Totals			Panel Total Connected Load: 25.6 KVA						

DIST. PANEL		Bus:	800	Additional Panel Notes:													
LBD				Main Type:		MLO		100% Neutral and Ground Buses									
				Volts:		208/120V, 3PH, 4W		BASE BID - Owner Furnished, Electrical Alternate EC-4 - Contractor Furnished									
				Poles:		24											
				AIC:		65,000											
				Mounting:		Surface											
CKT.	Breaker		Description		Notes	Load						Notes	Description	Breaker		CKT.	
	Amp	Pole				A		B		C				Pole	Amp		
1	150	3	Panel LD2	1	5.6	17.7							1	Panel LD1	3	225	2
3							5.6	17.7									4
5									5.6	17.7							6
7	250	3	Panel LE1	1	22.0	4.8							1	Panel LPG	3	150	8
9							22.0	4.8									10
11											22.0	4.8					12
13	250	3	Panel LC1	1	23.2	0.0							1	Temp Rental Generator Feeder / Spare	3	225	14
15							23.2	0.0									16
17											23.2	0.0					18
19		3	225A Provision		0.0	0.0								225A Provision	3		20
21							0.0	0.0									22
23											0.0	0.0					24
					73.3		73.3		73.3				Panel Section Connected Load:	220.0 KVA			
					Phase Totals						Panel Total Connected Load:	220.0 KVA					

PANELBOARD		Bus:	225A	Additional Panel Notes:										
LD1		Main Type:	MLO w/ SFL	100% Neutral and Ground Buses; Provide Sub-Feed Lugs (SFL)										
		Volts:	208/120V, 3PH, 4W											
		Poles:	42+42											
		AIC:	10,000											
Section 1 of 2		Mounting:	Flush											
CKT.	Breaker	Description	Notes	Load			Notes	Description	Breaker		CKT.			
	Amp			Pole	A	B			C	Pole		Amp		
1	20	1	Lighting D101, D102		0.5	0.2			Receptacles - Roof	1	20	2		
3	20	1	Lighting D105				0.5	0.5	EF-1 Roof	1	15	4		
5	20	1	Lighting D108					0.5	1.3	(E) FCU-1 D106	1	15	6	
7	20	1	Lighting D109		0.5	0.7				(E) FCU-2 D101	1	15	8	
9	20	1	Lighting D106				0.5	0.7		(E) FCU-3 D102	1	15	10	
11	20	1	Lighting D107,D110,D125, D114,D115					1.1	1.3	(E) FCU-4 D105	1	15	12	
13	20	1	Lighting D111		0.4	1.3				(E) FCU-6 D108	1	15	14	
15	20	1	Lighting D112, D113				0.5	1.3		(E) FCU-7 D109	1	15	16	
17	20	1	Lighting D124					0.4	0.0	(E) FCU-7 D107	1	15	18	
19	20	1	Lighting D121, D122		0.6	1.3	0.5	1.3		(E) FCU-8 E106	1	15	20	
21	20	1	Lighting D120							(E) FCU-5 E101	1	15	22	
23	20	1	Receptacles D120 W					0.7	1.3	(E) FCU-9 E105	1	15	24	
25	20	1	Receptacle Roof		0.2	0.0				Spare	1	20	26	
27	20	1	Spare				0.0	0.0		Spare	1	20	28	
29	20	1	Receptacles D117,D118					0.7	0.0	Spare	1	20	30	
31	20	1	Spare		0.0	0.0				Spare	1	20	32	
33	20	1	Spare				0.0	0.9		Receptacles D106 NW	1	20	34	
35	20	1	Receptacles D101 NW						0.7	0.7	Receptacles D106 S	1	20	36
37	20	1	Receptacles D101 E		0.7	4.1				RTU-5 Roof	3	45	38	
39	20	1	Receptacles D102 NE, D107									40		
41	20	1	Receptacles D102 SW									42		
					10.3		11.3	13.3	Panel Section Connected Load:		34.9 KVA			
					Phase Totals				Panel Total Connected Load:		53.2 KVA			

PANELBOARD		Bus:	225A	Additional Panel Notes:										
LD1		Main Type:		MLO	100% Neutral and Ground Buses									
		Volts:		208/120V , 3PH, 4W										
		Poles:		42+42										
		AIC:		10,000										
Section 2 of 2		Mounting:		Flush										
CKT.	Breaker	Description		Notes	Load			Notes	Description	Breaker		CKT.		
	Amp	Pole	A		B	C	Pole			Amp				
43	20	1	Receptacles D104 W		0.5	0.1			Lighting Exterior Area D	1	20	44		
45	20	1	Receptacles D104 Floor				0.5	0.9	Receptacles E106 E	1	20	46		
47	20	1	WC Receptacle D107					1.0	0.4	Receptacles E108 N	1	20	48	
49	20	1	Receptacles D105 W		0.5	0.5			Receptacles E108 E	1	20	50		
51	20	1	Receptacles D105 N				0.5	0.9	Receptacles E108 S	1	20	52		
53	20	1	Receptacles D105 S					0.9	1.3	E FCU-17 E108	1	15	54	
55	20	1	Receptacles D108 W		0.7	0.0			Spare	1	20	56		
57	20	1	Receptacles D108 N				1.1	0.0	Spare	1	20	58		
59	20	1	Receptacles D108 S					0.4	0.0	Spare	1	20	60	
61	20	1	Receptacles D109 W		0.5	0.0			Spare	1	20	62		
63	20	1	Receptacles D109 N				1.1	0.0	Spare	1	20	64		
65	20	1	Receptacles D109 S					0.5	0.0	Spare	1	20	66	
67	20	1	Receptacles E101 N		0.5	0.0			Spare	1	20	68		
69	20	1	Receptacles E101 S				0.0	0.7	Spare	1	20	70		
71	20	1	Receptacles E101 E					0.5	0.0	Spare	1	20	72	
73	20	1	Receptacles E102,E103,E104		0.7	0.0			3	Spare	1	20	74	
75	20	1	WC Receptacle D110	3			1.0	0.0	3	Spare	1	20	76	
77	20	1	Receptacles E105 W					0.4	0.0	Spare	1	20	78	
79	20	1	Receptacles E105 W		0.9	0.0			3	Spare	1	20	80	
81	20	1	Receptacles E106 N				0.9	0.0	3	Spare	1	20	82	
83	20	1	Receptacles E106 S					0.0	0.5	3	Spare	1	20	84
					4.9		7.6	5.8	Panel Section Connected Load:		18.3 KVA			
					Phase Totals				Panel Total Connected Load:		53.2 KVA			

PANELBOARD		Bus:	225A	Additional Panel Notes:										
LD2		Main Type:		MLO w/ SFL	100% Neutral and Ground Buses; Provide Sub-Feed Lugs (SFL)									
		Volts:		208/120V, 3PH, 4W										
		Poles:		42+42										
		AIC:		10,000										
Section 1 of 2		Mounting:		Surface										
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes	Description	Breaker		CKT.		
					A	B	C			Pole	Amp			
1	15	2	FV-5-6 D124		0.5	0.1			V Boxes Area D	1	15	2		
3							0.5	0.0				4		
5	15	2	FV-5-1 D111					0.5	0.0			6		
7					0.5	0.0						8		
9	15	2	FV-5-2 D112				0.5	0.0				10		
11												12		
13	15	2	FV-5-5 D121		0.5	0.0						14		
15							0.5	0.2		CUH-1(2),CUH-1(3),D114,D115	1	15	16	
17	15	2	FV-5-4 D120					0.5	0.1	CUH-1(1) D125	1	15	18	
19					0.5	0.0				Spare	1	20	20	
21	15	2	FV-5-3 D113				0.5	0.0		Spare	1	20	22	
23									0.0	Spare	1	20	24	
25	15	2	Spare		0.0	0.0				Spare	1	20	26	
27							0.0	0.0		Spare	1	20	28	
29	15	2	Spare					0.0	0.0	Spare	1	20	30	
31					0.0	0.0				Spare	1	20	32	
33	20	1	Spare				0.0	0.0		Spare	1	20	34	
35	20	1	Spare						0.0	Spare	1	20	36	
37	20	1	Spare	3	0.0	0.0			0.0	Spare	1	20	38	
39	20	1	Spare	3			0.0	0.0		Spare	1	20	40	
41	20	1	Spare	3					0.0	Spare	1	20	42	
					2.1	2.2		2.1		Panel Section Connected Load: 6.4 KVA				
					Phase Totals				Panel Total Connected Load: 16.9 KVA					

PANELBOARD		Bus:	225A	Additional Panel Notes:										
LD2		Main Type:		MLO	100% Neutral and Ground Buses									
		Volts:		208/120V , 3PH, 4W										
		Poles:		42+42										
		AIC:		10,000										
Section 2 of 2		Mounting:		Surface										
CKT.	Breaker Amp Pole	Description		Notes	Load			Notes	Description	Breaker		CKT.		
		A	B	C						Pole	Amp			
43	20 1	0.5							Spare	1	20	44		
45	20 1		0.7						Spare	1	20	46		
47	20 1			0.7					Spare	1	20	48		
49	20 1	0.5							Spare	1	20	50		
51	20 1		0.7						Spare	1	20	52		
53	20 1			0.7					Spare	1	20	54		
55	20 1	0.5							Spare	1	20	56		
57	20 1		0.5						Spare	1	20	58		
59	20 1			0.5					Spare	1	20	60		
61	20 1	0.5							Provision	1		62		
63	20 1		0.9						Provision	1		64		
65	20 1			0.7					Provision	1		66		
67	20 1	0.7							Provision	1		68		
69	20 1		0.5	0.0					Provision	1		70		
71	20 1			0.7	0.0			0.0	Provision	1		72		
73	20 1	0.7	0.0						Provision	1		74		
75	20 1		0.5	0.0					Provision	1		76		
77	20 1			0.0	0.0			0.0	Provision	1		78		
79	20 1	3	0.0	0.0					Provision	1		80		
81	20 1	3		0.0	0.0				Provision	1		82		
83	20 1	3			0.0			0.0	Provision	1		84		
				3.4	3.8	3.3	Panel Section Connected Load: 10.5 KVA							
				Phase Totals			Panel Total Connected Load: 16.9 KVA							

PANELBOARD		Bus:	225A	Additional Panel Notes:										
LE1		Main Type:		MLO w/ SFL	100% Neutral and Ground Buses; Provide Sub-Feed Lugs (SFL)									
		Volts:		208/120V, 3PH, 4W										
		Poles:		42+42										
		AIC:		10,000										
Section 1 of 2		Mounting:		Surface										
CKT.	Breaker	Description		Notes	Load			Notes	Description	Breaker		CKT.		
	Amp	Pole	A		B	C	Pole			Amp				
1	20	1	Lighting E101		0.5	0.2			Receptacles - Roof	1	20	2		
3	20	1	Lighting E102,E103,E104				0.3	0.2				4		
5	20	1	Lighting E107,E124,						0.7	1.2		6		
7	20	1	Lighting E105		0.5	1.2					1	20	8	
9	20	1	Lighting E108				0.5	0.1			1	15	10	
11	20	1	Lighting E106						0.5	0.0		1	20	12
13	20	1	Lighting E116, E117		0.4	0.9					1	20	14	
15	20	1	Lighting E118				0.3	0.4			1	20	16	
17	20	1	Lighting E119						0.4	0.7	1	20	18	
19	20	1	Lighting E120		0.4	0.7					1	20	20	
21	20	1	Lighting E113,E122				0.4	0.4			1	20	22	
23	20	1	Lighting E123						0.4	0.7	1	20	24	
25	60	3	DWHP-2 E115		6.3	0.7					1	20	26	
27							6.3	0.7			1	20	28	
29									6.3	0.4	1	20	30	
31	20	1	(E) EF		0.1	1.1					1	20	32	
33	20	1	Spare	3			0.0	1.1			1	20	34	
35	20	1	Spare	3					0.0	0.5	1	20	36	
37	20	1	Spare	3	0.0	5.0					1	20	38	
39	20	1	Spare	3			0.0	5.0			3	60	40	
41	20	1	Spare	3					0.0	5.0			42	
					17.8		15.6	16.6	Panel Section Connected Load:		50.0 KVA			
					Phase Totals			Panel Total Connected Load:		65.9 KVA				

PANELBOARD		Bus:	225A	Additional Panel Notes:										
LE1		Main Type:		MLO	100% Neutral and Ground Buses									
		Volts:		208/120V, 3PH, 4W										
		Poles:		42+42										
		AIC:		10,000										
Section 2 of 2		Mounting:		Surface										
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes	Description	Breaker		CKT.		
					A	B	C			Pole	Amp			
43	20	1	Receptacles E120 S		1.1				Spare	1	15	44		
45	20	1	Receptacles E112, E113			0.7	1.3		E FCU-5 E101	1	15	46		
47	20	1	Receptacles E122 W					0.9	1.3	(E) FCU-9 E105	1	15	48	
49	20	1	Receptacles E122 E		0.7	1.3			(E) FCU-8 E106	1	15	50		
51	20	1	Receptacles E122 S				0.5	0.1	CUH-1 (5) E124	1	15	52		
53	20	1	Receptacles E123 E					0.9	0.1	UH-1 (2) E114	1	15	54	
55	20	1	Receptacles E123 S		0.4	0.1			CUH-1 (6) E124	1	15	56		
57	20	1	Receptacles E123 W				0.7	0.3	FV-6-1 E117	2	15	58		
59	20	1	Lighting Exterior Area E									60		
61	20	1	Spare		0.0	0.5		0.2	0.3	FV-6-2 E118	2	15	62	
63	20	1	Spare				0.0	0.5				64		
65	20	1	Spare						0.5	FV-6-3 E119	2	15	66	
67	20	1	Spare		0.0	0.5						68		
69	20	1	Spare				0.0	0.5		FV-6-4 E120	2	15	70	
71	20	1	Spare					0.0	0.5			72		
73	20	1	Spare		0.0	0.5				FV-6-5 E122	2	15	74	
75	20	1	Spare				0.0	0.5				76		
77	20	1	Spare						0.5	FV-6-6 E123	2	15	78	
79	20	1	Spare	3	0.0	0.5						80		
81	20	1	Spare	3			0.0	0.0		Spare	2	15	82	
83	20	1	Spare	3				0.0	0.0			84		
					5.6	5.1	5.2		Panel Section Connected Load:	15.9 KVA				
					Phase Totals				Panel Total Connected Load: 65.9 KVA					

PANELBOARD		Bus:	225A	Additional Panel Notes:										
LK1		Main Type:		MLO w/ FTL	100% Neutral and Ground Buses; Provide Feed Through Lugs (FTL)									
		Volts:		208/120V , 3PH, 4W	Provide with integral transient voltage surge suppression unit Type L2									
		Poles:		42										
		AIC:		65,000										
		Mounting:		Flush										
CKT.	Breaker	Description		Notes	Load			Notes	Description	Breaker		CKT.		
	Amp	Pole			A	B	C			Pole	Amp			
1	15	1	Spare	3		2.0				3	25	2		
3	15	1	Spare	3			2.0					4		
5	15	1	Spare	3				2.0				6		
7	20	1	Spare	3		1.8				3	20	8		
9	20	1	Spare	3			1.8			3	20	10		
11	20	1	Spare	3				0.2	0.0	3	15	12		
13	20	1	Rec #25 Work Table		0.2	1.3					3	20	14	
15	15	2	Spare	3			0.8	1.3				16		
17												18		
19	30	2	Dryer		4.0	6.4					3	70	20	
21							4.0	6.4				22		
23	20	1	Washer						0.5			24		
25	20	1	Rec B138,B141, B142		1.3	1.9				3	20	26		
27	20	1	Rec B137				0.9	0.0			1	15	28	
29	20	1	Rec B132, B135,B136, B138						1.1	0.0	1	20	30	
31	20	1	CUH-1 (11) B138		0.1	0.0					1	20	32	
33	25	3	(E) AHU-4 B138				1.8	0.0			1	20	34	
35									1.8	0.0	1	20	36	
37					1.8	0.0					3	20	38	
39	15	1	Spare				0.0	0.0				40		
41	15	1	Spare						0.0	0.0		42		
					20.8	18.9	14.0	Panel Section Connected Load: 53.7 KVA						
					Phase Totals			Panel Total Connected Load: 53.7 KVA						

PANELBOARD		Bus:	225A	Additional Panel Notes:									
LPG		Main Type:	MLO	100% Neutral and Ground Buses. Provide integral transient voltage surge suppression unit Type L2.									
		Volts:	208/120V, 3PH, 4W										
		Poles:	42										
		AIC:	10,000										
		Mounting:	Flush										
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes		Description	Breaker		CKT.
					A	B	C				Pole	Amp	
1	20	1	Theatrical Lighting Circuit		0.0	0.0				Gym Equipment Relay Panel Ctrl	1	20	2
3	20	1	Theatrical Lighting Circuit			0.0				Future Scoreboard North	1	20	4
5	20	1	Theatrical Lighting Circuit				0.0			Future Scoreboard Southwest	1	20	6
7	20	1	Theatrical Lighting Circuit		0.0	1.0				Backstop Height Adjuster	1	20	8
9	20	1	Theatrical Lighting Circuit			0.0				Backstop Raise/Lower	1	20	10
11	20	1	Theatrical Lighting Circuit				0.0		1.0	AV Cabinet - Platform	1	20	12
13	20	1	Theatrical Lighting Circuit		0.0	0.0				Chair Lift C123	2		14
15	20	1	Theatrical Lighting Circuit			0.0							16
17	20	1	Theatrical Lighting Circuit				0.0		1.0	Backstop Height Adjuster	1	20	18
19	20	1	Platform Projector and Screen		1.0	1.0				Backstop Raise/Lower	1	20	20
21	20	1	Platform Lift			0.0				Backstop Height Adjuster	1	20	22
23	20	1	Motorized Shades				0.0		1.0	Backstop Raise/Lower	1	20	24
25	20	1	Motorized Shades		0.0	1.0				Backstop Height Adjuster	1	20	26
27	20	1	Spare			0.0				Backstop Raise/Lower	1	20	28
29	20	1	Spare				0.0		1.0	Backstop Height Adjuster	1	20	30
31	20	1	Spare		0.0	1.0				Backstop Raise/Lower	1	20	32
33	20	1	Spare			0.0				Backstop Height Adjuster	1	20	34
35	20	1	Spare				0.0		1.0	Backstop Raise/Lower	1	20	36
37	20	1	Spare	3	0.0	0.2				Receptacle Platform W	1	20	38
39	20	1	Spare	3		0.0				Receptacle Platform E	1	20	40
41	20	1	Spare	3			0.0		0.0	Spare	1	20	42
				Phase Totals			5.2	4.2	5.0	Panel Section Connected Load:	14.4 KVA		
										Panel Total Connected Load:	14.4 KVA		

EX PANEL	Bus:	100A	Additional Panel Notes: [Cutlar Hammer Pow-R-Line C Type PRL1A] Panel Provided For Reference Only									
LP-AP	Main Type:	MLO	Existing 100% Neutral and Ground Buses									
	Volts:	208/120V, 3PH, 4W										
	Poles:	30										
	AIC:	Existing										
Mounting:			Flush	[] denotes existing load description.								
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes	Description	Breaker Pole	Amp	CKT.
					A	B	C					
1	20	1	[Rec - Auditorium]	11,15	0.5	0.3		11,15	[Ltg - Rear Stage]	1	20	2
3	20	1	[Rec - Aud. Floor in Back]	11,15		0.4	0.4	11,15	[Rec - Rear Stage]	1	20	4
5	20	1	[Ltg - Outside Overhang Front]	11,15			0.3	0.4	[Rec - Rear Stage]	1	20	6
7	20	1	[Spot Lights]	15,17	1.0	1.0		11,15	[Art Rm Exhaust Fan]	1	20	8
9	20	1	[Stage Lights]	11,15		1.0	0.3	11,15	[Ltg - Rm 114]	1	20	10
11	20	1	[Ltg, Clocks, Storage]	11,15			0.3	0.3	[Ltg - Rm 115]	1	20	12
13	20	1	[Ltg - Outside Overhang Side]	11,15	0.3	0.0		15	[Spare]	1	20	14
15	20	1	[Fan Storage]	11,15		0.3	0.3	11,15	[Ltg - By Kieln]	1	20	16
17	20	1	[Ltg - Rm 117]	11,15			0.3	0.0	[Spare]	1	20	18
19	20	1	[Ltg - Janitor, Art Rm]	11,15	0.3	0.0		15,17	[Spare]	3	20	20
21	20	1	[Old 114]	11,15		0.4	0.0					22
23	20	1	[Rec - Boiler Rm]	11,15			0.4	0.0				24
25	20	1	[Rec - Boiler Rm]	11,15	0.4	0.0		15	[Spare]	1	20	26
27	20	1	[Rec - Boiler Rm]	11,15			0.4	0.0	[Spare]	1	20	28
29	20	1	[Spare]	15			0.0	0.0	[Spare]	1	20	30
				Phase Totals			3.6	3.2	1.7	Panel Section Connected Load:		
										Panel Total Connected Load:		
										8.5 KVA		
										8.5 KVA		

EX PANEL	Bus:	100A	Additional Panel Notes: [Cutlar Hammer Pow-R-Line C Type PRL1A] Panel Provided For Reference Only									
LP-1	Main Type: MLO		Existing 100% Neutral and Ground Buses									
	Volts: 208/120V, 3PH, 4W											
	Poles: 30											
	AIC: Existing											
	Mounting: Flush		[] denotes existing load description.									
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes	Description	Breaker Pole	Amp	CKT.
					A	B	C					
1	20	1	[Ltg - Cafeteria]	11,15	0.3	0.0		15	[Spare]	2	20	2
3	20	1	[Spare]	15,17		0.0	0.0					4
5	20	1	[Ltg - Boiler Rm]	11,15			0.3	0.3	[Ltg - Corridor]	1	20	6
7	20	1	[Water Cooler]	11,15	0.5	0.3		11,15	[Ltg - Cafeteria]	1	20	8
9	20	1	[Rec - Rm 114]	11,15		0.5		11,15	[Rec - Rm 114]	1	20	10
11	20	1	[Rec - Rm 114]	11,15			0.5	0.3	[Ltg - Kitchen, Trash, Dishwashing]	1	20	12
13	20	1	[Rec - Rm 114]	11,15	0.5	0.4		11,15	[Clock, Ceiling Fan]	1	20	14
15	20	1	[Rec - Rm 114]	11,15		0.5	0.0	15	[Spare at Kitchen Switch]	1	20	16
17	20	1	[FCU - Rm 114]	11,15			1.4	0.5	[Rec - Rm 114]	1	20	18
19	20	1	[Rec - Cafeteria]	11,15	0.5	0.5		11,15	[Rec - Rm 114]	1	20	20
21	20	1	[Rec - Art Rm, Closet]	11,15		0.5	0.3	11,15	[Ltg - Outside Courtyard]	1	20	22
23	20	2	[Rec - 220V - Rm 114]	11,15			1.0	0.0	[Spare]	1	20	24
25					1.0	1.4		11,15	[FCU - Rm 115]	1	20	26
27	20	2	[Rec - 220V - Rm 114]	11,15		1.0	0.0	15	[Spare]	1	20	28
29							1.0	0.0	[Spare]	1	20	30
				Phase Totals			5.4	3.4	5.2	Panel Section Connected Load:		
										Panel Total Connected Load:		
										14.0 KVA		
										14.0 KVA		

EX PANEL		Bus:	225A	Additional Panel Notes: [Cutlar Hammer Pow-R-Line C Type PRL1A] Panel Provided For Reference Only												
LP-2				Main Type:		MLO	Existing 100% Neutral and Ground Buses									
				Volts:		208/120V, 3PH, 4W										
				Poles:		30										
				AIC:		Existing										
				Mounting:		Flush										
				[.] denotes existing load description.												
CKT.	Breaker		Description		Notes	Load			Notes	Description	Breaker		CKT.			
	Amp	Pole	A	B		C	Pole	Amp								
1	20	1	[Ltg - Library]		11,15	0.3	0.8			11,15	[Exhaust Fan]	1	20	2		
3	20	1	[.]		11,15			0.3	0.5		[Power Supply Front Doors]	1	20	4		
5	20	1	[.]		11,15					0.3	0.0	1	20	6		
7	20	1	[Ltg - Library]		11,15	0.3	0.8			11,15	[Exhaust Fan 2, 17,18 Bathrms]	1	20	8		
9	20	1	[.]		11,15			0.3	0.3		[Time Clock Outside Ltg]	1	20	10		
11	20	1	[.]		11,15					0.3	0.5	1	20	12		
13	20	1	[Ltg - Library]		11,15	0.3	0.8			11,15	[Exhaust Fan Principal Bathrm]	1	20	14		
15	20	1	[Rec - Faculty Coffee Pot]		11,15			1.0	0.7	11,15	[Rec - Office, Principal]	1	20	16		
17	20	1	[Rec - Main Office Fax Machine]		11,15	0.5	0.0			11,15	[Ltg - Library Workrm]	1	20	18		
19	20	1	[Rec - Hallway]		11,15					15	[Spare to Rm #10 in Switch Box]	1	20	20		
21	20	1	[Rec - Hallway]		11,15			0.5	0.0	15	[Spare to Rm #10 in Switch Box]	1	20	22		
23	20	1	[Spare]		15					11,15	[.]	1	20	24		
25	20	1	[Rec - Hallway]		11,15	0.5	0.3			11,15	[Ltg - Outside Near Front Door]	1	20	26		
27	20	1	[.]		11,15			0.4	0.0	15	[Spare]	1	20	28		
29	20	1	[Rec - Library Work Shop]		11,15					11,15	[Rec - Hallway, Clock Library]	1	20	30		
					4.4			3.8		3.4		Panel Section Connected Load: 11.6 KVA				
								Phase Totals		Panel Total Connected Load: 11.6 KVA						

EX PANEL	Bus:	100A	Additional Panel Notes: [Cutler Hammer Pow-R-Line C Type PRL1A] Panel Provided For Reference Only									
LP-3	Main Type:	MLO	Existing 100% Neutral and Ground Buses									
	Volts:	208/120V, 3PH, 4W										
	Poles:	30										
	AIC:	Existing										
	Mounting:	Flush	[] denotes existing load description.									
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes	Description	Breaker		CKT.
1	20	1	[Ltg - Classrm 101]	11,15	0.3	0.3			[Ltg - Classrm 104]	Pole	Amp	2
3	20	1	[FCU-30 Rm 101]	11,15			1.4	1.4	[FCU-33 Rm 104]	1	20	4
5	20	1	[Ltg - Classrm 100]	11,15					[Ltg - Classrm 107]	1	20	6
7	20	1	[FCU-29 Rm 100]	11,15	1.4	1.4			[FCU-36 Rm 107]	1	20	8
9	20	1	[Ltg - Classrm 103]	11,15			0.3	0.3	[Ltg - Classrm 106]	1	20	10
11	20	1	[FCU-32 Rm 103]	11,15					[FCU-35 Rm 106]	1	20	12
13	20	1	[Ltg - Classrm 102]	11,15	0.3	0.3		1.4	[Ltg - Showcase]	1	20	14
15	20	1	[FCU-31 Rm 102]	11,15			1.4	0.5	[Rec - Classrm 1,3]	1	20	16
17	20	1	[Ltg - Classrm 105]	11,15					[Rec - Classrm 5,7]	1	20	18
19	20	1	[FCU-34 Rm105]	11,15	1.4	0.5			[Rec - Classrm 2,4]	1	20	20
21	20	2	[FCU-37,40 Hallway]	11,15			1.4	0.5	[Rec - Classrm 6,8]	1	20	22
23									[Spare]	2	20	24
25	20	2	[Spare]	15,17	0.0	0.0						26
27							0.0	0.0	[Spare]	2	20	28
29	20	1	[Rec - Corridor]	11,15								30
				Phase Totals			5.7	7.1	5.8	Panel Section Connected Load:		
										Panel Total Connected Load:		
										18.6 KVA		
										18.6 KVA		

EX PANEL		Bus:	100A	Additional Panel Notes: [Cutlar Hammer Pow-R-Line C Type PRL1A] Panel Provided For Reference Only											
LP-4				Main Type:	MLO	Existing 100% Neutral and Ground Buses									
				Volts:	208/120V, 3PH, 4W										
				Poles:	30										
				AIC:	Existing										
				Mounting:	Flush	[] denotes existing load description.									
CKT.	Breaker Amp Pole	Description	Notes	Load			Notes	Description	Breaker		CKT.				
				A	B	C			Pole	Amp					
1	20 1	[Ltg - Classrm 142]	11,15	0.3	0.5		11,15	[Rec - Classrm 11,13]	1	20	2				
3	20 1	[FCU-20 Rm 142]	11,15		1.4	0.5	11,15	[Rec - Classrm 12,10]	1	20	4				
5	20 1	[Ltg - Classrm 145]	11,15			0.3	0.5	[Rec - Corridor]	1	20	6				
7	20 1	[FCU-23 Rm 145]	11,15	1.4	0.3		11,15	[Ltg - Corridor]	1	20	8				
9	20 1	[Ltg - Classrm 144]	11,15		0.3	0.0	15	[Spare]	2	20	10				
11	20 1	[FCU-21 Rm 144]	11,15			1.4	0.0				12				
13	20 1	[Ltg - Classrm 147]	11,15	0.3	0.0		15	[Spare]	2	20	14				
15	20 1	[FCU-24 Rm 147]	11,15		1.4	0.0					16				
17	20 1	[Ltg - Classrm 146]	11,15				15	[Spare]	1	20	18				
19	20 1	[FCU-22 Rm 146]	11,15	1.4	1.4		11,15	[FCU-14 Hallway]	1	20	20				
21	20 1	[Ltg - Classrm 149]	11,15		0.3	0.3	11,15	[Ltg - Boy/Girl Stor..]	1	20	22				
23	20 1	[FCU-25 Rm 149]	11,15			1.4	0.0	[Spare]	1	20	24				
25	20 1	[Ltg - Classrm 15]	11,15	0.3	1.5		11,15	[Washer / Dryer]	2	30	26				
27	20 1	[Spare	15		0.0	1.5					28				
29	20 1	[Ltg - Outside, Time Clocks]	11,15				11,15	[Rec - Corridor]	1	20	30				
			7.2			5.6		4.6		Panel Section Connected Load: 17.3 KVA					
						Phase Totals		Panel Total Connected Load: 17.3 KVA							

EX SWITCHBOARD				Bus:	1,600A	Additional Notes: [Siemens Type SB3] Switchboard Provided For Reference	
MDB				Main Type:	1,600A MLO	Existing 100% Neutral and Ground Buses; NEMA 3R Enclosure	
				Features:	-		
				Volts:	208/120V, 3PH, 4W		
				Space:	As Shown		
				AIC:	Existing		
				Mounting	Free Standing		
SECT	CKT	Breaker Amp	Pole	Features/ Type	Description	KVA	Notes
1					[Wire Pulling Section]		
2	1	800	3	-	[Chiller]	205.6	15
	2	1,000	3	-	[Distribution Panels MDP & NDP]	437.4	11, 15
Total Connected Load KVA:						437.4	Peak Utility Electrical Demand 5/2022 Through 6/2024 = 209.3 KW

EX DIST. PANEL		Bus:	600A	Additional Panel Notes: [Cutler Hammer Pow-R-Line-C Type PDL4] Panel Provided For Reference Only												
MDP				Main Type:		MLO	Existing 100% Neutral and Ground Buses									
				Volts:		208/120V, 3PH, 4W										
				Poles:		24										
				AIC:		Existing										
				Mounting:		Surface	[] denotes existing load description.									
CKT.	Breaker Amp	Pole	Description		Notes	Load			Notes	Description	Breaker Pole Amp		CKT.			
1	200	3	[Auditorium Light Control Panel]		15	15.0	14.9			15	[Panels PB-A & PB-B]	3	200	2		
3							15.0	14.9						4		
5								15.0	14.9						6	
7	200	3	[Panels LP-2 & LP-3]		15	10.1	6.2			15	[Panels CP-1 & CP-2]	3	200	8		
9								10.1	6.2						10	
11													10.1	6.2	12	
13	150	3	[Panel LP-4		15	5.8	11.2			15	[Panel KP]	3	100	14		
15									5.8				11.2		16	
17													5.8	11.2	18	
19	100	3	[Panel LP-AP]		15	2.8	4.7			15	[Panel LP-1]	3	100	20		
21									2.8				4.7		22	
23													2.8	4.7	24	
						70.6		70.6		70.6	Panel Section Connected Load:		211.9 KVA			
						Phase Totals					Panel Total Connected Load:		211.9 KVA			

SWITCHBOARD			Bus:	4,000A	Additional Notes:	
MDS			Main Type:	MCB (See Below)	BASE BID - Owner Furnished, Electrical Alternate EC-4 - Contractor Furnished Front accessible only. NEMA 1. 100% neutral and ground busbars. Service entrance rated. Provide Digital Power Meter with Communication Provide Arc Flash Energy Reduction Switch	
			Features:	(See Below)		
			Volts:	208/120V, 3PH, 4W		
			Space:	As Shown		
			AIC:	65,000		
			Mounting	Free Standing		
SECT	CKT	Breaker Amp Pole	Features/ Type	Description	KVA	Notes
1	0	-	-	Fire Pump Connection Section		20
	-	-	-	Incoming U/G Transition Section	-	-
2	-	2,500	AUX,EN1,E P,AFR	Incoming U/G Transition Section	-	1
3	1	800	EP,AFR	Chiller	205.6	1,11
	2	800	EP,AFR	Distributioni Panel LDB	220.0	1
	3	800	EP,AFR	Temp. Backfeed of Panels NBP,NDP & MDP	0.0	1
	4	600	EP,AFR,HC	Panel ODP via ATS-O1	214.3	1,9; Optional Standby System #1
	5	225	E,HC	Panel EDP via ATS-LS	13.3	1,9; Life Safety System
	6	150	TM	Panel LA1	18.4	1
	7	150	TM	Panel LA2	9.9	1
	8	150	TM	Panel LB1	11.4	1
	9	150	TM	Panel LB2	32.8	1
	10	150	TM	Panel LC2	25.6	1
	11	225	TM	Panel LK1	53.7	1
	12	150	TM	Spare	0.0	1
	13	150	TM	Spare	0.0	
	14	225	TM	Spare	0.0	
	15	100	TM	RTU-4	30.8	
	16	100	TM	Spare	0.0	
	17			225A/3P Breaker Space Provision		
	18			225A/3P Breaker Space Provision		
	20	60	-	Transient Voltage Surge Suppressor Unit Type L1	0.0	4
	21	800	EP,AFR	Panel HPV via ECB-HPV, T-HPV, FS-HPV	0.0	1,14; Roof Photovoltaic Input
Total Connected Load KVA:					835.8	

EX PANEL		Bus:	225A	Additional Panel Notes: [Westinghouse Pow-R-Line C Type PRL1] Panel Provided For Reference Only															
NA				Main Type:		MLO	Existing 100% Neutral and Ground Buses												
				Volts:		208/120V , 3PH, 4W													
				Poles:		42													
				AIC:		Existing													
				Mounting:		Surface													
				[.] denotes existing load description.															
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.							
	Amp	Pole			A	B	C			Pole	Amp								
1	20	1	[Comp. Equip. Rm 210]	11,15	0.5	0.5			11,15	[Comp. Equip. Rm 205]	1	20	2						
3	20	1	[Comp. Equip. Rm 209]	11,15			0.5	0.5		11,15	[Comp. Equip. Rm 205]	1	20	4					
5	20	1	[Comp. Equip. Rm 208]	11,15				0.5	0.5	11,15	[Comp. Equip. Admin. Area]	1	20	6					
7	20	1	[Comp.Equip.Admin., Rec-Library Wkrm]	11,15	0.5	0.5				11,15	[Comp. Equip. Rm 18A]	1	20	8					
9	20	1	[Comp. Equip. Rm 16]	11,15			0.5	0.5		11,15	[Comp. Equip. Rm 18A]	1	20	10					
11	20	1	[Comp.Equip.Rm 16,Library Pwr Poles]	11,15				0.5	0.5	11,15	[Comp. Equip. Rm 17]	1	20	12					
13	20	1	[Rec - Rm 19]	11,15	0.5	0.7				11,15	[Rec - Rms 16,24]	1	20	14					
15	20	1	[Rec - Rm 16, Library]	11,15			0.7	0.7		11,15	[Ltg - Principal & Conference]	1	20	16					
17	20	1	[Rec - Rm 15,15A, Faculty Dining]	11,15				0.7	0.5	11,15	[Fire Alarm]	1	20	18					
19	20	1	[Rec - Library]	11,15	0.7	0.7				11,15	[Ltg - Admin. Area]	1	20	20					
21	20	1	[Rec]	11,15			0.4	0.3		11,15	[Ltg - Nurse Area]	1	20	22					
23	20	1	[Ltg - Lobby]	11,15					0.3	11,15,17	[ACUV/1 - Rm 15A]	2	20	24					
25	20	1	[Rec - Rm 17, 18A]	11,15	0.7	1.0								26					
27	20	1	[Rec - Copier]	11,15			1.0	1.0		11,15	[ACUV/1 - Rm 15A]	1	20	28					
29	20	1	[Rec - Laminator Faculty Lounge]	11,15					0.5	11,15	[ACUV/2 - Rm 17]	1	20	30					
31	30	2	[Spare]	11,15,17	0.0	1.0				11,15	[ACUV/2 - Rm 17]	1	20	32					
33							0.0	1.0		11,15	[ACUV/2 - Rm 17]	1	20	34					
35	20	1	[Rec - Rm 18 18A]	11,15					0.7	0.3	11,15	[Motorized Drapes ini Library]	1	20	36				
37	20	1	[Spare]	11,15	0.0	0.5				11,15	[]	1	20	38					
39	20	1	[FCU - Rm 115A]	11,15			1.1	1.0		11,15	[Rec - Faculty Soda Machine]	1	20	40					
41	20	1	[Heat Trace - AHU]	11,15					0.1	0.5	11,15	[Rec - Nurse]	1	20	42				
					8.1		9.3		7.7	Panel Section Connected Load:					25.1 KVA				
					Phase Totals					Panel Total Connected Load:					25.1 KVA				

EX PANEL		Bus:	225A	Additional Panel Notes: [Westinghouse Pow-R-Line C Type PRL1] Panel Provided For Reference Only									
NBP				Main Type:		125A/3P MCB		Existing 100% Neutral and Ground Buses					
				Volts:		208/120V, 3PH, 4W							
				Poles:		30							
				AIC:		Existing							
				Mounting:		Surface		[.] denotes existing load description.					
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.	
	Amp	Pole			A	B	C			Pole	Amp		
1	20	1	[U.V. Nurse]	11,15	0.5	1.6		11,15	[AHU-4 - Café.]	3	30	2	
3	20	3	[A/C Unit - Nurse]	11,15,17			1.0	1.6				4	
5								1.0	1.6			6	
7					1.0	3.2			[RTAHU - Library Roof]	3	30	8	
9		1	[Provision]	13			0.0	3.2				10	
11		1	[Provision]	13				0.0	3.2			12	
13		1	[Provision]	13	0.0	0.0			[Provision]	1		14	
15	20	1	[Univent in Café.]	11,15			0.7	0.0	[Provision]	1		16	
17	20	1	[Spare]	15,17				0.0	[Spare]	1	20	18	
19	20	1	[Spare]	15,17	0.0	0.0			[Spare]	1	20	20	
21	20	2	[Spare]	15,17			0.0	0.0	[Spare]	2	20	22	
23								0.0	0.0			24	
25	50	3	[Spare]	15,17	0.0	0.0			[Spare]	1	20	26	
27							0.0	0.0	[Spare]	2	20	28	
29								0.0	0.0			30	
					6.3		6.5	5.8	Panel Section Connected Load:		18.6 KVA		
					Phase Totals				Panel Total Connected Load:		18.6 KVA		

EX DIST. PANEL		Bus:	600A	Additional Panel Notes: [Cutler Hammer Pow-R-Line-C Type PDL3] Panel Provided For Reference Only															
NDP				Main Type:		MLO		Existing 100% Neutral and Ground Buses											
				Volts:		208/120V , 3PH, 4W													
				Poles:		42													
				AIC:		Existing													
				Mounting:		Surface													
				[] denotes existing load description.															
CKT.	Breaker Amp Pole	Description		Notes	Load			Notes	Description	Breaker Pole Amp		CKT.							
					A	B	C												
1	1	1	[Provision]	13	0.0	0.0			13	[Provision]	1	2							
3	1	1	[Provision]	13			0.0	0.0	13	[Provision]	1	4							
5	1	1	[Provision]	13				0.0	0.0	13	[Provision]	6							
7	1	1	[Provision]	13	0.0	6.0			11,15	[Classroom Trailers]	3	100							
9	1	1	[Provision]	13			0.0	6.0				8							
11	1	1	[Provision]	13								10							
												12							
13	125	3	[Panel EP via ATS-EP]	11,15	17.4							14							
15							17.4					16							
17								17.4				18							
19	150	3	[Panel NA]	11,15	8.4							20							
21							8.4					22							
23								8.4				24							
25	225	3	[Panels 3L & 3P]	11,15	17.7							26							
27							17.7					28							
29								17.7				30							
31	200	3	[Panel NBP]	11,15	6.2							32							
33							6.2					34							
35								6.2				36							
37	225	3	[Panels 2L & 2P]	11,15	19.5							38							
39							19.5					40							
41								19.5				42							
					75.2		75.2		75.2	Panel Section Connected Load: 225.5 KVA									
					Phase Totals				Panel Total Connected Load: 225.5 KVA										

DIST. PANEL		Bus:	600A	Additional Panel Notes:									
ODP		Main Type:	400A/3P MCB Notes 7.9	100% Neutral and Ground Buses; Provide Transient Voltage Surge Protection Unit L2									
		Volts:	208/120V , 3PH, 4W	BASE BID - Owner Furnished, Electrical Alternate EC-4 - Contractor Furnished									
		Poles:	42										
		AIC:	65,000										
(OPT. STANDBY)		Mounting:	Surface										
CKT.	Breaker	Description	Notes	Load			Notes	Description	Breaker		CKT.		
	Amp			Pole	A	B			C	Pole		Amp	
1	150	3	Panel OLA1	1,9	10.0	6.9		1,9	Panel OLB1	3	150	2	
3							10.0	6.9				4	
5									10.0	6.9		6	
7	225	3	Panel OLK1	1,9	12.7	0.0		1,9	SPARE	3	150	8	
9							12.7	0.0				10	
11								12.7	0.0			12	
13	150	3	Panel OLD1	1,9	1.7	10.7		1,9	RTU Admin. Suite	3	100	14	
15							1.7	10.7				16	
17								1.7	10.7			18	
19	100	3	P-3	1,9	9.4	9.4		1,9	P-4	3	100	20	
21							9.4	9.4				22	
23								9.4	9.4			24	
25	90	3	MAU Kitchen	1,9	7.2	3.4		1,9	Panel OLA2	3	150	26	
27							7.2	3.4				28	
29								7.2	3.4			30	
31	100	3	SPARE	9	0.0	0.0		9	SPARE	3	150	32	
33							0.0	0.0				34	
35								0.0	0.0			36	
37		3	PROVISION		0.0	0.0		4	TVSS UNIT L2	3	60	38	
39							0.0	0.0				40	
41								0.0	0.0			42	
					71.4		71.4		Panel Section Connected Load:	214.3 KVA			
					Phase Totals				Panel Total Connected Load:	214.3 KVA			

PANELBOARD			Bus:	225A	Additional Panel Notes:														
OLA1			Main Type:		MLO w/ FTL	100% Neutral and Ground Buses; Provide Feed Through Lugs (FTL)													
			Volts:		208/120V, 3PH, 4W	Provide with integral transient voltage surge suppression unit Type L2													
			Poles:		42+42														
			AIC:		22,000														
			Mounting:		Flush														
Section 1 of 2																			
CKT.	Breaker	Amp	Pole	Description	Notes	Load			Notes	Description	Breaker		CKT.						
						A	B	C			Pole	Amp							
1	20	1		Lighting A125,A126, A128-A132		0.6	1.0			3	Receptacle B101 Refrigerator	1	20	2					
3	20	1		Lighting A114A-A117, A119-A121				0.4	0.9		Receptacles B101,B102,B103	1	20	4					
5	20	1		Lighting A101A,102A,103A109A,112A,113A						1.0	Receptacle B101 Copier	1	20	6					
7	20	1		Lighting B101,B102, B104,B105		0.6	0.9				Receptacles A126, A127	1	20	8					
9	20	1		Lighting B103, B108-B111				0.6	0.5		Receptacles A126	1	20	10					
11	20	1		Receptacles B104, Exterior						1.1	Receptacles A125	1	20	12					
13	20	1		Receptacles B104,B112,B110		0.0	0.7				Receptacles A128	1	20	14					
15	20	1		Receptacles A120				0.7	0.7		Receptacles A129	1	20	16					
17	15	1		V-Boxes Area A						0.5	Receptacles A130,A133	1	20	18					
19	15	1		V-Boxes Area B		0.1	0.7				Receptacles A131	1	20	20					
21	20	1		Receptacles B104 W				0.4	0.7		Receptacles A132	1	20	22					
23	20	1		Receptacles B104 Desk						1.1	Receptacles B108,A133,A105A	1	20	24					
25	20	1		Receptacles B104,B105		0.7	1.1				Receptacles B109	1	20	26					
27	20	1		Receptacle B104 Copier				1.0	0.5		Receptacles B111 Desk W	1	20	28					
29	20	1		Receptacles B105						0.7	Receptacles B111 Cots	1	20	30					
31	20	1		Receptacle B101 N		0.2	0.2				Receptacles B111 Scale	1	20	32					
33	20	1		Receptacle B101 Laminator				1.0	1.0		Receptacle B111 Refrigerator	1	20	34					
35	20	1		Receptacle B101 PA System						0.4	Receptacles B110 Counter	1	20	36					
37	20	1		Receptacle B101 Coffee		1.0	1.1				Receptacles B111 Desk S	1	20	38					
39	20	1		Receptalce B101 Counter				0.2	0.4		Receptacles B110	1	20	40					
41	20	1		Receptacle B101 Microwave						0.2	Lighting A133	1	20	42					
						8.9		8.9		9.5	Panel Section Connected Load: 27.3 KVA								
						Phase Totals					Panel Total Connected Load: 30.0 KVA								

PANELBOARD		Bus:	225A	Additional Panel Notes:									
OLA1		Main Type:	MLO	100% Neutral and Ground Buses									
		Volts:	208/120V, 3PH, 4W										
		Poles:	42+42										
		AIC:	22,000										
Section 2 of 2		Mounting:	Flush										
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes		Description	Breaker		CKT.
					A	B	C				Pole	Amp	
43	20	1	Flag Pole Lighting		0.1	1.0				Door Hardware Power Supplies	1	20	44
45	20	1	Motorized Door - Vest. B107 Ext.			0.7	1.0			Door Hardware Power Supplies	1	20	46
47	20	1	Motorized Door - Vest. B107 Int.				0.0	0.0		Spare	1	20	48
49	20	1	Spare		0.0	0.0				Spare	1	20	50
51	20	1	Spare			0.0	0.0			Spare	1	20	52
53	20	1	Spare				0.0	0.0		Spare	1	20	54
55	20	1	Spare		0.0	0.0				Spare	1	20	56
57	20	1	Spare			0.0	0.0			Spare	1	20	58
59	20	1	Spare				0.0	0.0		Spare	1	20	60
61	20	1	Spare	3	0.0	0.0				Spare	1	20	62
63	20	1	Spare	3		0.0	0.0			Spare	1	20	64
65	20	1	Spare	3			0.0	0.0		Spare	1	20	66
67		1	Provision		0.0	0.0				Provision	1		68
69		1	Provision			0.0	0.0			Provision	1		70
71		1	Provision				0.0	0.0		Provision	1		72
73		1	Provision		0.0	0.0				Provision	1		74
75		1	Provision			0.0	0.0			Provision	1		76
77		1	Provision				0.0	0.0		Provision	1		78
79		1	Provision		0.0	0.0				Provision	1		80
81		1	Provision			0.0	0.0			Provision	1		82
83		1	Provision				0.0	0.0		Provision	1		84
					1.1	1.7	0.0			Panel Section Connected Load:	2.7 KVA		
					Phase Totals					Panel Total Connected Load:	30.0 KVA		

PANELBOARD		Bus:	225A	Additional Panel Notes:									
OLA2		Main Type:	MLO	100% Neutral and Ground Buses									
		Volts:	208/120V, 3PH, 4W	Provide with integral transient voltage surge suppression unit Type L2									
		Poles:	42										
		AIC:	22,000										
		Mounting:	Surface										
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes		Description	Breaker		CKT.
					A	B	C				Pole	Amp	
1	20	1	Quad Receptacle W A117		0.4	2.3				CU-2 Roof	2	30	2
3	20	1	Quad Receptacle S A117			0.4	2.3						4
5	20	1	Quad Receptacle Rack A117										6
7	20	1	Quad Receptacle Rack A117		0.4	0.9				FASEP (Temporary Breaker)	1	20	8
9	20	1	Receptacle E A117							FASEP (Temporary Breaker)	1	20	10
11	20	1	Quad Receptacle N A117							Receptacle - Security Equipment	1	20	12
13	20	1	Spare		0.0	0.4				Receptacle - Security Equipment	1	20	14
15	20	1	Spare			0.0	0.0			Spare	1	20	16
17	20	1	Spare				0.0			Spare	1	20	18
19	20	1	Spare		0.0	0.0				Spare	1	20	20
21	20	1	Spare			0.0	0.0			Spare	1	20	22
23	20	1	Spare				0.0			Spare	1	20	24
25	20	1	Spare		0.0	0.0				Spare	1	20	26
27	20	1	Spare	3		0.0			3	Spare	1	20	28
29	20	1	Spare	3		0.0	0.0		3	Spare	1	20	30
31		1	Provision		0.0	0.0				Provision	1		32
33		1	Provision			0.0	0.0			Provision	1		34
35		1	Provision				0.0			Provision	1		36
37		1	Provision		0.0	0.0				Provision	1		38
39		1	Provision			0.0	0.0			Provision	1		40
41		1	Provision				0.0			Provision	1		42
					4.3	3.9	2.1			Panel Section Connected Load:	10.3 KVA		
					Phase Totals					Panel Total Connected Load:	10.3 KVA		

PANELBOARD		Bus:	225A	Additional Panel Notes:										
OLB1		Main Type:		MLO	100% Neutral and Ground Buses									
		Volts:		208/120V , 3PH, 4W	Provide with integral transient voltage surge suppression unit Type L2									
		Poles:		42										
		AIC:		22,000										
		Mounting:		Surface										
CKT.	Breaker Amp Pole	Description		Notes	Load			Notes	Description	Breaker		CKT.		
1	20 1	(E) Chiller Heat Trace			1.5	1.0			CU-4 Roof	Pole 2	Amp 15	2		
3	20 1	(E) Boiler B1					0.0	1.0				4		
5	20 1	(E) Boiler B2							Spare			6		
7	20 3	P-1			2.0							8		
9									CU-5 Roof			10		
11												12		
13	20 3	P-2			1.3	1.2			Loading Dock Roll Up Door	1	20	14		
15							1.3	0.1	DWH-K B130	1	15	16		
17								1.3	0.1	CP-2 B130	1	15	18	
19	20 1	ATC Panel			0.5	1.5			MTS Strip Heater	1	20	20		
21	20 1	Door Hardware Power Supplies					1.0	0.0	Spare	1	20	22		
23	20 1	Door Hardware Power Supplies						1.0	0.0	Spare	1	20	24	
25	20 1	Spare			0.0	0.0			Spare	1	20	26		
27	20 1	Spare					0.0	0.0	Spare	1	20	28		
29	20 1	Spare						0.0	0.0	Spare	1	20	30	
31	20 1	Spare			0.0	0.0			Spare	1	20	32		
33	20 1	Spare	3				0.0	0.0	Spare	3	20	34		
35	20 1	Spare	3					0.0	0.0			36		
37	20 1	Spare	3		0.0	0.0						38		
39	20 1	Spare	3				0.0	0.0	Spare	2	15	40		
41	20 1	Spare	3					0.0	0.0			42		
					9.0	6.4	5.4	Panel Section Connected Load:					20.8 KVA	
					Phase Totals				Panel Total Connected Load:					20.8 KVA

PANELBOARD		Bus:	225A	Additional Panel Notes:									
OLD1		Main Type:	MLO	100% Neutral and Ground Buses									
		Volts:	208/120V, 3PH, 4W	Provide with integral transient voltage surge suppression unit Type L2									
		Poles:	42										
		AIC:	22,000										
		Mounting:	Surface										
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes		Description	Breaker		CKT.
					A	B	C				Pole	Amp	
1	20	1	Lighting D103,D116,D149,D150,D151		0.3	1.0				Door Hardware Power Supplies	1	20	2
3	20	1	Receptacle D103			0.2	1.0			Door Hardware Power Supplies	1	20	4
5	20	1	Rack Receptacle D103				0.4	0.0		Spare	1	20	6
7	20	1	Rack Receptacle D103		0.4	0.0				Spare	1	20	8
9	15	2	CU-6 Roof			1.0	0.0			Spare	1	20	10
11							1.0	0.0		Spare	1	20	12
13	20	1	Spare		0.0	0.0				Spare	1	20	14
15	20	1	Spare			0.0	0.0			Spare	1	20	16
17	20	1	Spare				0.0	0.0		Spare	1	20	18
19	20	1	Spare		0.0	0.0				Spare	1	20	20
21	20	1	Spare			0.0	0.0			Spare	1	20	22
23	20	1	Spare				0.0	0.0		Spare	1	20	24
25	20	1	Spare	3	0.0	0.0			3	Spare	1	20	26
27	20	1	Spare	3		0.0	0.0		3	Spare	1	20	28
29	20	1	Spare	3			0.0	0.0	3	Spare	1	20	30
31		1	Provision		0.0	0.0				Provision	1		32
33		1	Provision			0.0	0.0			Provision	1		34
35		1	Provision				0.0	0.0		Provision	1		36
37		1	Provision		0.0	0.0				Provision	1		38
39		1	Provision			0.0	0.0			Provision	1		40
41		1	Provision				0.0	0.0		Provision	1		42
					1.6	2.1	1.4			Panel Section Connected Load:	5.1 KVA		
					Phase Totals					Panel Total Connected Load:	5.1 KVA		

PANELBOARD		Bus:	225A	Additional Panel Notes:									
OLE1		Main Type:	MLO	100% Neutral and Ground Buses									
		Volts:	208/120V, 3PH, 4W	Provide with integral transient voltage surge suppression unit Type L2									
		Poles:	42										
		AIC:	22,000										
		Mounting:	Surface										
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes		Description	Breaker		CKT.
					A	B	C				Pole	Amp	
1	20	1	Receptacles E114		0.4	1.0				CU-3 Roof	2	15	2
3	20	1	Lighting E112,E146,E114-E116			0.2	1.0						4
5	20	1	Receptacles E110,E111										
7	20	1	Rack Receptacle E109		0.4	1.0				Door Hardware Power Supplies	1	20	6
9	20	1	Spare			0.0	0.0			Door Hardware Power Supplies	1	20	8
11	20	1	Spare							Spare	1	20	10
13	20	1	Spare		0.0	0.0				Spare	1	20	12
15	20	1	Spare			0.0	0.0			Spare	1	20	14
17	20	1	Spare				0.0			Spare	1	20	16
19	20	1	Spare		0.0	0.0				Spare	1	20	18
21	20	1	Spare			0.0	0.0			Spare	1	20	20
23	20	1	Spare							Spare	1	20	22
25	20	1	Spare	3	0.0	0.0				Spare	1	20	24
27	20	1	Spare	3					3	Spare	1	20	26
29	20	1	Spare	3		0.0	0.0		3	Spare	1	20	28
31		1	Provision		0.0	0.0			3	Spare	1	20	30
33		1	Provision							Provision	1		32
35		1	Provision			0.0	0.0			Provision	1		34
37		1	Provision		0.0	0.0				Provision	1		36
39		1	Provision							Provision	1		38
41		1	Provision			0.0	0.0			Provision	1		40
					2.7	1.2	0.0			Provision	1		42
					Phase Totals					Panel Section Connected Load:	5.5 KVA		
					1.7					Panel Total Connected Load:	5.5 KVA		

PANELBOARD		Bus:	225A	Additional Panel Notes:									
OLK1		Main Type:	MLO w/ FTL	100% Neutral and Ground Buses; Provide Feed Through Lugs (FTL)									
		Volts:	208/120V, 3PH, 4W	Provide with integral transient voltage surge suppression unit Type L2									
		Poles:	42+42										
		AIC:	22,000										
Section 1 of 2		Mounting:	Flush										
CKT.	Breaker Amp Pole	Description		Notes	Load			Notes	Description	Breaker		CKT.	
		A	B	C						Pole	Amp		
1	15 1	0.5	0.5						#17 Hood Lights and Controls	1	15	2	
3	15 1		0.5	0.7					#18 Fire Suppression System	1	20	4	
5	45 3						4.1	0.8	Rec #27 Two Section Refrigerator	1	15	6	
7		4.1	0.3						Rec#30 Milk Cooler	1	15	8	
9							4.1	0.8	Rec # 34 Cold Food Counter	1	20	10	
11	45 3						0.0	1.0	Rec #35 Ice Cream Cabinet	1	20	12	
13		0.0	1.1						Rec #21 DD Convection Oven	1	15	14	
15							0.0		(Shunt Trip)			16	
17	15 1						0.2	1.1	Rec #21 DD Convection Oven	1	15	18	
19		1.1							(Shunt Trip)			20	
21							1,1	0.2	Rec #22 DD Convection Steamer	1	15	22	
23	20 1								(Shunt Trip)			24	
25	20 1	0.2	0.8						Rec #24 DD Conveyor Oven	1	20	26	
27	20 1						0.2		(Shunt Trip)			28	
29	20 1				3				Rec #24 DD Conveyor Oven	1	20	30	
31	20 1	1.2	0.0					0.8	(Shunt Trip)	1	20	32	
33	15 2				3		0.8	0.2	Receptacle Worktable	1	20	34	
35									Spare	1	20	36	
37	20 1	0.0	0.1						Contactor Control	1	20	38	
39	20 1						0.0	0.0	Spare	1	15	40	
41	20 1							0.0	(Shunt Trip)			42	
				9.9	7.5	10.8	Panel Section Connected Load: 28.1 KVA						
				Phase Totals			Panel Total Connected Load: 38.1 KVA						

PANELBOARD		Bus:	225A	Additional Panel Notes:										
OLK1		Main Type:		MLO	100% Neutral and Ground Buses									
		Volts:		208/120V , 3PH, 4W										
		Poles:		42+42										
		AIC:		22,000										
Section 2 of 2		Mounting:		Flush										
CKT.	Breaker Amp	Pole	Description	Notes	Load			Notes	Description	Breaker		CKT.		
43	20	3	KEF-1 Roof		1.1	0.6				Lighting B138,B141, B142,B143	Pole	Amp	44	
45						1.1	0.8				Lighting B130, B132- B137	1	20	46
47									1.1	0.4	Receptacle B134 N	1	20	48
49	15	1	KEF-2 Roof		0.9	0.4				Receptacle B134 Rack	1	20	50	
51	15	1	EF-5 Roof				0.2	0.4		Receptacle B134 Rack	1	20	52	
53	15	2	CU-1 Roof					1.0	0.4	Receptacle B134 W	1	20	54	
55						1.0	0.4				Receptacle B134 E	1	20	56
57	15	1			Spare				0.0	0.4		Receptacle B134 S	1	20
59	15	1	Spare						0.0	Spare	1	20	60	
61	15	1	Spare		0.0	0.0				Spare	1	20	62	
63	15	1	Spare				0.0	0.0		Spare	1	20	64	
65	20	1	Spare						0.0	Spare	1	20	66	
67	20	1	Spare		0.0	0.0				Spare	1	20	68	
69	20	1	Spare				0.0	0.0		Spare	1	20	70	
71	20	1	Spare						0.0	Spare	1	20	72	
73	20	1	Spare	3	0.0	0.0				Spare	1	20	74	
75	20	1	Spare	3			0.0	0.0		Spare	1	20	76	
77	20	1	Spare	3					0.0	Spare	1	20	78	
79	20	3	Spare		0.0	0.0				Spare	1	20	80	
81							0.0	0.0		Spare	1	20	82	
83									0.0	Spare	1	20	84	
					4.3	2.9		2.8		Panel Section Connected Load: 10.0 KVA				
					Phase Totals				Panel Total Connected Load: 38.1 KVA					

EX PANEL		Bus:	225A	Additional Panel Notes: [Cutlar Hammer Pow-R-Line C Type PRL1] Panel Provided For Reference Only									
PB-A				Main Type:		MLO	Existing 100% Neutral and Ground Buses						
				Volts:		208/120V, 3PH, 4W							
				Poles:		30							
				AIC:		Existing							
				Mounting:		Surface							
				[.] denotes existing load description.									
CKT.	Breaker	Description	Notes	Load			Notes	Description	Breaker		CKT.		
				A	B	C			Pole	Amp			
1	50	3 [KIELN]	11,15,17	0.0	3.3			11,15	[Existing Circuit]	3	50	2	
3						0.0	3.3					4	
5							0.0	3.3				6	
7	30	3 [AHU]	11,15,17	0.0	3.3			11,15,17	[Existing Circuit]	3	50	8	
9						0.0	3.3					10	
11							0.0	3.3				12	
13	20	1 [Time Clock]	11,15	0.4	0.2			11,15	[Boiler Rm Damper]	1	20	14	
15	20	1 [Ltg - Outside]	15			0.3	0.7	11,15	[Hot Water Heater Fan]	1	20	16	
17	15	3 [Spare]	15,17					11,15,17	[Stage Closet Fan]	3	15	18	
19				0.0	0.0							20	
21						0.0	0.0					22	
23	15	1 [Spare]	15					11,15	[Stage Closet Fan]	1	15	24	
25	30	3 [Pump #1]	15,17	0.0	0.4			11,15	[Cock and Intercom]	3	20	26	
27						0.0	0.4					28	
29												30	
				7.6		8.0		8.0		Panel Section Connected Load: 23.6 KVA			
						Phase Totals				Panel Total Connected Load: 23.6 KVA			

EX PANEL		Bus:	100A	Additional Panel Notes: [Cutlar Hammer Pow-R-Line C Type PRL1A] Panel Provided For Reference Only									
PB-B				Main Type:		100A/3P MCB		Existing 100% Neutral and Ground Buses					
				Volts:		208/120V , 3PH, 4W							
				Poles:		42							
				AIC:		Existing							
				Mounting:		Surface							
				[.] denotes existing load description.									
CKT.	Breaker	Description		Notes	Load			Notes	Description	Breaker		CKT.	
		Amp	Pole		A	B	C			Pole	Amp		
1	20	3	[Spare]	15,17	0.0	0.0			15,17	[Spare]	2	20	2
3							0.0	0.0					4
5									0.0	0.0	1	20	6
7	15	1	[Spare]	15,17	0.0	0.0			15,17	[Spare]	1	20	8
9	15	1	[Spare]	15,17					15,17	[Spare]	1	20	10
11	20	1	[Spare]	15,17			0.0	0.0	15,17	[Spare]	1	20	12
13	20	1	[Spare]	15,17	0.0	0.0			15,17	[Spare]	3	15	14
15	20	1	[Spare]	15,17			0.0	0.0					16
17	20	1	[Spare]	15,17				0.0	0.0				18
19	15	3	[Spare]	15,17	0.0	0.0			15,17	[Spare]	3	15	20
21							0.0	0.0					22
23								0.0	0.0				24
25	15	3	[Spare]	15,17	0.0	0.0			15,17	[Spare]	3	15	26
27							0.0	0.0					28
29							0.0	0.0					30
31	40	3	[Spare]	15,17	0.0	0.0			15,17	[Spare]	3	20	32
33							0.0	0.0					34
35								0.0	0.0				36
37	100	3	[New (2) Disconnect CPA/B 100A]	11,15	7.0	0.0			15,17	[Spare]	3	50	38
39							7.0	0.0					40
41													42
				7.0			7.0		7.0		Panel Section Connected Load: 21.0 KVA		
											Panel Total Connected Load: 21.0 KVA		

EX PANEL		Bus:	225A	Additional Panel Notes: [Westinghouse Pow-R-Line C Type PRL1] Panel Provided For Reference Only										
2L				Main Type:		MLO	Existing 100% Neutral and Ground Buses							
				Volts:		208/120V , 3PH, 4W								
				Poles:		42								
				AIC:		Existing								
				Mounting:		Flush								
				[.] denotes existing load description.										
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.		
	Amp	Pole			A	B	C			Pole	Amp			
1	20	1	[Ltg - Classrm 122]	11,15	0.3	0.3			11,15	[Ltg - Gym 220 G]	1	20	2	
3	20	1	[FCU - Rm 122]	11,15			1.4	0.3		11,15	[Ltg - Gym 220 C]	1	20	4
5	20	1	[FCU - Rm 124]	11,15				1.4	0.3	11,15	[Ltg - Gym 220 D]	1	20	6
7	20	1	[Ltg - Classrm 124]	11,15	0.3	0.3				11,15	[Ltg - Gym 220 E]	1	20	8
9	20	1	[Ltg - Classrm 126]	11,15			0.3	0.3		11,15	[Ltg - Gym 220 A]	1	20	10
11	20	1	[FCU - Rm 126]	11,15					1.4	0.3	[Ltg - Gym 220 B]	1	20	12
13	20	1	[Ltg - Classrm 120A]	11,15	0.3	0.3				11,15	[Ltg - Toilets & Stor. 211,212,213]	1	20	14
15	20	1	[Spare]	15			0.0	0.3		11,15	[Ltg - Stor. 214, 215, 216]	1	20	16
17	20	1	[Ltg - Office 120 & 120B]	11,15					0.3	0.3	[Ltg - Corr. & Main Lobby]	1	20	18
19	20	1	[Ltg - Lobby 202]	11,15	0.3	0.3				11,15	[Ltg - Corr.]	1	20	20
21	20	1	[Ltg - Lobby 202]	11,15			0.3	0.3		11,15	[Ltg - Vest. 217, 203 & Outside]	1	20	22
23	20	1	[Spare]	15					0.0	0.3	[Ltg - Courtyard]	1	20	24
25	20	1	[Spare]	15	0.0	0.3				11,15	[Ltg - Gym 220 F]	1	20	26
27	20	1	[Spare]	15			0.0	0.3		11,15	[]	1	20	28
29	20	1	[Spare]	15					0.0	0.0	[Spare]	1	20	30
31	20	1	[Spare]	15	0.0	0.0				11,15	[Spare]	1	20	32
33	20	1	[Spare]	15			0.0	0.0		11,15	[Spare]	1	20	34
35	20	1	[Spare]	15					0.0	0.0	[Spare]	1	20	36
37	20	3	[Spare]	15	0.0	16.4				11,15	[Panel 2P]	3	100	38
39							0.0	16.4					40	40
41									0.0	16.4			42	42
				18.6			19.5		20.4		Panel Section Connected Load: 58.5 KVA			
							Phase Totals			Panel Total Connected Load: 58.5 KVA				

EX PANEL		Bus:	225A	Additional Panel Notes: [Westinghouse Pow-R-Line C Type PRL1] Panel Provided For Reference Only															
2P				Main Type:		MLO	Existing 100% Neutral and Ground Buses												
				Volts:		208/120V , 3PH, 4W													
				Poles:		42													
				AIC:		Existing													
				Mounting:		Flush													
				[.] denotes existing load description.															
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.							
	Amp	Pole			A	B	C			Pole	Amp								
1	20	1	[Rec - Classrm 122]	11,15	0.7	0.5			11,15	[Rec - Gym]	1	20	2						
3	20	1	[Rec - Classrm 124]	11,15			0.7	0.7		11,15	[Rec - Gym, Stor. & Corr.]	1	20	4					
5	20	1	[Rec - Classrm 126]	11,15				0.7	0.5	11,15	[Rec - Mezz. Level]	1	20	6					
7	20	1	[Rec - Classrm 124 GFI]	11,15	0.7	0.7				11,15	[Rec - Gym & Outdoor]	1	20	8					
9	20	1	[Rec - Off & Outdoor GFI]	11,15			0.7	0.4		11,15	[Rec - EWC & Clock Outlet]	1	20	10					
11	20	1	[Rec - Lobby Area]	11,15					0.5	3.2	11,15	[AHU-1 Mezz. Level]	3	50	12				
13	20	1	[Spare]	11,15	0.0	3.2								14					
15	20	1	[AHU-1 Pump]	11,15				1.0	3.2					16					
17	20	1	[AHU-2 Pump]	11,15					1.0	3.2	11,15	[AHU-2 Mezz. Level]	3	50	18				
19	20	1	[FCU - Rm 120]	11,15	1.3	3.2								20					
21	20	1	[FCU - Rm 120A]	11,15				1.3	3.2					22					
23	20	1	[HVAC Rm 217, 218]	11,15						0.9	11,15	[EF-3 Mezz. Level]	3	15	24				
25	20	1	[EF-1 Mezz. Area]	11,15	1.0	0.9								26					
27	20	1	[Gym - Backboard Motor]	11,15				1.2	0.9					28					
29	20	1	[Gym - Backboard Motor]	11,15						0.0	11,15	[Spare]	1	20	30				
31	20	1	[FCU - Main Hall Entrance]	11,15	1.3	0.4					11,15	[Rec - Stor.]	1	20	32				
33	20	1	[Spare]	11,15			0.0	0.5			11,15	[Rec - Bell in Gym]	1	20	34				
35	20	1	[Spare]	11,15						0.0	11,15	[]	1	20	36				
37	20	1	[]	11,15	0.0	0.0					11,15	[]	1	20	38				
39	20	2	[]	11,15			0.0	4.5			11,15	[Kiln Rm 123]	2	60	40				
41									0.0	4.5				42					
				13.9			18.2			17.0			Panel Section Connected Load: 49.1 KVA						
							Phase Totals						Panel Total Connected Load: 49.1 KVA						

EX PANEL		Bus:	225A	Additional Panel Notes: [Westinghouse Pow-R-Line C Type PRL1] Panel Provided For Reference Only												
3L				Main Type:		MLO	Existing 100% Neutral and Ground Buses									
				Volts:		208/120V, 3PH, 4W										
				Poles:		42										
				AIC:		Existing										
				Mounting:		Flush										
				[.] denotes existing load description.												
CKT.	Breaker	Description	Notes	Load			Notes	Description	Breaker		CKT.					
				A	B	C			Pole	Amp						
1	20	1 [Ltg - Classrm 143]	11,15	0.3	0.3		11,15	[Ltg - Classrm 137]	1	20	2					
3	20	1 [FCU - Rm 143]	11,15		1.4	1.4	11,15	[FCU - Classrm 137]	1	20	4					
5	20	1 [FCU - Rm 138]	11,15			1.4	11,15	[FCU - Classrm 135]	1	20	6					
7	20	1 [Ltg - Classrm 138]	11,15	0.3	0.3		11,15	[Ltg - Classrm 135]	1	20	8					
9	20	1 [Ltg - Classrm 136]	11,15		0.3	0.3	11,15	[Ltg - Classrm 133]	1	20	10					
11	20	1 [FCU - Rm 136]	11,15			1.4	11,15	[FCU - Classrm 133]	1	20	12					
13	20	1 [Ltg - Classrm 128]	11,15	0.3	0.3		11,15	[Ltg - Classrm 129]	1	20	14					
15	20	1 [FCU - Rm 128]	11,15		1.4	0.3	11,15	[Ltg - Classrm 131]	1	20	16					
17	20	1 [Ltg - Classrm 141]	11,15			0.3	11,15	[Ltg - Boys & Girls Bathrm]	1	20	18					
19	20	1 [Ltg - Classrm 139]	11,15	0.3	0.0		11,15	[Spare]	1	20	20					
21	20	1 [Ltg]	11,15		0.3	0.5	11,15	[Rec - Storage 140]	1	20	22					
23	20	1 [Spare]	15			0.0	11,15	[Rec - Outside & Vest.]	1	20	24					
25	20	1 [Spare]	15	0.0	0.5		11,15	[Rec - Computer Equip 128]	1	20	26					
27	20	1 [Computer Equip 139]	11,15		0.5	0.5	11,15	[Rec - Computer Equip 129]	1	20	28					
29	20	1 [Computer Equip 138]	11,15			0.5	11,15	[Rec - Computer Equip 131]	1	20	30					
31	20	1 [Computer Equip 136]	11,15	0.5	0.5		11,15	[Rec - Computer Equip 133]	1	20	32					
33	20	1 [Spare]	15		0.0	0.5	11,15	[Rec - Computer Equip 135]	1	20	34					
35	20	1 [Spare]	15			0.0	11,15	[Rec - Computer Equip 137]	1	20	36					
37	20	3 [Spare]	15	0.0	11.4		11,15	[Panel 3P]	3	100	38					
39											40					
41											42					
			14.7	18.7	19.5	Panel Section Connected Load: Panel Total Connected Load:										
			Phase Totals			53.0 KVA 53.0 KVA										

EX PANEL		Bus:	225A	Additional Panel Notes: [Westinghouse Pow-R-Line C Type PRL1] Panel Provided For Reference Only												
3P				Main Type:		MLO	Existing 100% Neutral and Ground Buses									
				Volts:		208/120V, 3PH, 4W										
				Poles:		42										
				AIC:		Existing										
				Mounting:		Flush										
				[.] denotes existing load description.												
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.				
	Amp	Pole			A	B	C			Pole	Amp					
1	20	2	[Rec - Classrm 143]	11,15	0.5	1.1			11,15,19	[Rec - Classrm 128]	1/1	20/20	2			
3			[Rec - Classrm 141]				0.5	1.1		[Rec - Classrm 129]	1/1	20/20	4			
5	20/20	1/1	[Rec - Classrm 139]	11,15,19					1.1	[Rec - Classrm 131]	1/1	20/20	6			
7	20/20	1/1	[Rec - Classrm 138]	11,15,19	1.1	0.5				[Rec - Classrm 133]	2	20	8			
9	20	1	[Rec - Classrm 136]	11,15			0.5	0.5		[Rec - Classrm 135]			10			
11	20	1	[Rec - Back Hallway]	11,15					0.5	[Rec - Classrm 137]	2	20	12			
13	20	1	[Rec - 143,141,139 GFI]	11,15	0.5	0.4				[Rec - Outside GFI]			14			
15	20	1	[Rec - 138 GFI]	11,15			0.4	0.4		[Rec - Jan Closet GFI]	1	20	16			
17	20	1	[Rec - GFI]	11,15					0.4	[Rec - 133 Area GFI]	1	20	18			
19	20	1	[]	11,15	0.5	2.5				[WH/1]	2	30	20			
21	20	1	[FCU - Hallway Front]	11,15			1.1	2.5					22			
23	20	1	[FCU - Classrm 129]	11,15					1.1	[HW RP/1]	1	20	24			
25	20	1	[FCU - Classrm 139]	11,15	1.1	1.1				[FCU - Classrm 131]	1	20	26			
27	20	1	[FCU - Classrm 141]	11,15			1.1	1.0		[HVAC Unit - Vest.]	1	20	28			
29	20	1	[FCU - Hallway Back]	11,15					1.1	[HVAC Units - Toilets 130, 134]	1	20	30			
31	20	2	[Spare]	11,15	0.0	0.0				[Spare]	1	20	32			
33							0.0	0.7		[HWRP]	1	20	34			
35	20	2	[A/C Unit Rm 129]	11,15					1.0	[A/C Unit Rm 131]	2	20	36			
37					1.0	1.0							38			
39	20	1	[Rec - 140 Refrig]	11,15			1.0	0.5			2	20	40			
41	20	1	[]	11,15						[]			42			
				11.5			11.4			11.3			Panel Section Connected Load: 34.1 KVA			
													Panel Total Connected Load: 34.1 KVA			

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

LUMINAIRE SCHEDULE

Mark	Manufacturer	Catalog Number	Description	Volts	Lamps				Driver		Mtg.	Mtg. Height	Notes
					No.	Watts	Type/Lumens	No.	Type				
CH1	Lithonia	CLX-L48 SEF FDL MVOLT GZ10 35K 80CR OCL series CSL series SNLED series	4' LED industrial	UNV	1	31	LED 4000	1	DLD	CH	8'-6" AFF UON	1,3,12	
CH2	Lithonia	CSS L48 AL03 MVOLT SWW3 80CRI	Existing 4' industrial	UNV	1	35	LED 4800	1	DLD	CH	8'-6" AFF UON		
EX1	Dual-lite	Existing Exit Sign	Existing LED exit sign single/dual face	UNV	-	-	LED	-	-	SW/SC		2,3	
EX1A	Lithonia	LQM-S-W-3-R-120/277	LED exit sign single/dual face	UNV	-	-	LED	-	-	SW/SC		2,3	
OC1	Lithonia	LLP4-08LM-40K-G4-80CRI-EZ10-CP-WS-XXX-WET	Lensed 4" wall wash downlight; maximum housing height of 2-1/8"; IC-rated; wet location listed; fully serviceable from below ceiling	UNV	1	7.5	LED 658	1	DLD	RC	Cltg Hgt	3,6	
OG1	Kim Lighting	LTV83-SS-SP-12L-4K-UV-SR	Flush mounted, adjustable aiming, in- ground light for flagpole lighting	UNV	1	14	LED 1180	1	DLD	IG	Grade	3,11	
OP1	Lithonia	DSX1 LED-P1-40K-80CRI-T4M-MVOLT-SPA-NL TAIR2 PIRHN-XXX	Single head, 18-foot square pole, Type II Medium distribution	UNV	1	51	LED 7507	2	DLD	PM	Pole Base	3,6,10	
OP1/ HS	Lithonia	DSX1 LED-P1-40K-80CRI-T4M-MVOLT-SPA-NL TAIR2 PIRHN-XXX-HS	Single head, 18-foot square pole, Type II Medium distribution; house-side shield	UNV	1	51	LED 7507	2	DLD	PM	Pole Base	3,6,10	
OP1/2	Lithonia	DSX1 LED-P1-40K-80CRI-T4M-MVOLT-SPA-NL TAIR2 PIRHN-XXX	Two head, 180-degree apart, 18-foot square pole, Type II Medium distribution, full cutoff	UNV	2	51	LED 7507	2	DLD	PM	Pole Base	3,6,10	
OP2	Lithonia	RADPT IED-P1-40K-PATH-MVOLT-PT4-NL TAIR2-XX-XXXXX with RSS-10-4B-PT-XXXXX	120" pole mounted circular post top pathway luminaire; Pathway Type 3 optics; house-side shield; full cutoff	UNV	1	21	LED 2739	1	DLD	PM	Pole Base	3,6,10	

Mark	Manufacturer	Catalog Number	Description	Volts	Lamps			Driver		Mtg. Height	Notes	
					No.	Watts	Type/Lumens	No.	Type			
OP3	Lithonia	DSX1 LED-P1-40K-80CRI-TFTM-MVOLT-SPA-NLTAIR2 PIRHN-XXX	Single head, 18-foot square pole, Forward Throw Medium distribution;full cutoff	unv	1	51	LED 7507	1	DLD	PM	Pole Base	3,6,10
OP3/HS	Lithonia	DSX1 LED-P1-40K-80CRI-TFTM-MVOLT-SPA-NLTAIR2 PIRHN-XXX	Single head, 18-foot square pole, Forward Throw Medium distribution; house side shield; full cutoff	unv	1	51	LED 7507	1	DLD	PM	Pole Base	3,6,10
OW1	Lithonia	WPX2 LED-40K-MVOLT-PE-XX	DLC wall pack with full cut-off; IP66 housing	UNV	1	24	LED 2913	1	DLD	SW	144"U.O.N.	6,7
OW2	Luminaire LED LSI	BLD-24"-MIN10-10W-40K-MVOLT-DP-XXX-PIR LiniArc LAW2 Series	LED 24" wall-mounted luminaire, with motion/photocell; full cutoff	UNV	1	10	LED 1024	1	DLD	SW	6" above door or mullion mtd if applicable	6,7
OW2B	Luminaire LED LSI	BLD-36"-MIN10-15W-40K-MVOLT-DP-XXX-PIR LiniArc LAW2 Series	LED 36" wall-mounted luminaire, with motion/photocell; full cutoff	UNV	1	30	LED 3000	1	DLD	SW	6" above door or mullion mtd if applicable	6,7
OW2C	Luminaire LED LSI	BLD-48"-MIN10-20W-40K-MVOLT-DP-XXX-PIR LiniArc LAW2 Series	LED 48" wall-mounted luminaire, with motion/photocell	UNV	1	20	LED 2049	1	DLD	SW	6" above door or mullion mtd if applicable	6,7
OW2D	Luminaire LED LSI	BLD-72"-MIN10-30W-40K-MVOLT-DP-XXX-PIR LiniArc LAW2 Series	LED 72" wall-mounted luminaire, with motion/photocell	UNV	1	30	LED 3159	1	DLD	SW	6" above door or mullion mtd if applicable	6,7
P1	Lithonia	Existing Lighting Fixture (JCBL 30000LM ACCR 120 GZ10 35K 80CRI PM WG (LAOZU) SCF120 DWHXD	Existing Gymnasium – LED high bay with wire cage	UNV	1	204	LED 30000	1	DLD	AH		
P2	OCL Architectural Lighting	TB3-P1FJ-24-XX-XXX-LED2-WF-LED1-35K-UNV-X-DM1	3" diameter 24" long luminous cylinder with 60 degree downlight, suitable for angled ceiling mounting, stem mounting, separately switched body and downlight, remote power supplies	UNV	1 1	25	LED 2200 LED 1240	2	DLD	P	Pendant length varies	1,3,6,7,8

Mark	Manufacturer	Catalog Number	Description	Volts	Lamps			Driver		Mtg.	Mtg. Height	Notes
					No.	Watts	Type/Lumens	No.	Type			
P4	Systemalux	3700-8'-BO/MO-835F-F-UNV01-D01	Direct/Indirect linear pendant with 1-1/2" aperture	UNV	1	84	LED 3572	2	DLD		Bottom of fixture at 10'AFF U.N.O	1,3,6,7,8
P5	Impact Lighting	P5222-35HI-XX-XXXX	22-inch diameter oval-shaped luminous disc pendant	UNV	1	18	LED 2080	1	DLD	P	Varies	3,5,6,8
P6	OCL Architectural Lighting	TB3-P1FJ48-XX-XXX-LED2-ND-35K-UNV-X-DM1	3" diameter 48" long luminous cylinder with 60 degree downlight, suitable for angled ceiling mounting, stem mounting, separately switched body and downlight, remote power supplies	UNV	1 1	48	LED 4400 LED 2200	2	DLD	P	Pendant length varies	1,3,6,7,8
P7	SPI Lighting	Chatham AI8179-6N100-120V-DF_80-DF_OA-DF_STM-OAH=xx	33" traditional opal acrylic diffuser pendant with metal trim (DAO)	120	6	14	Screw-in LED 1500 each	1	PCD	P	114" AFF to bottom of fixture	1,3,6,7,8,13
RC1	Hubbell	Existing Lighting Fixture	Existing LED 2'x4' flat panel	UNV	1	49	LED 5400	1	DLD	RC		9
RC2	Hubbell	Existing Lighting Fixture	Existing LED 2'x4' flat panel	UNV	1	38	LED 4000	1	DLD	RC		9
RC3	Lithonia	CPX 2x4 4000LM 80CRI 35K SWL MIN10 ZT MVOLT	2'x4' flat panel	UNV	1	37	LED 4000	1	DLD	RC		
RC4	Lithonia	EPANL2X4 4000LM 80CRI 35K MIN1 MVOLT	2'x4' flat panel	UNV	1	38	LED 4000	1	DLD	RC		
RC4A	Lithonia	EPANL2X4 4000LM 80CRI 35K MIN1 MVOLT	2'x4' flat panel	UNV	1	38	LED 4000	1	DLD	RC		
RC4B	Lithonia	EPANL2X4 5400LM 80CRI 35K MIN1 MVOLT	2'x4' flat panel	UNV	1	49	LED 5400	1	DLD	RC		
RC4D	Lithonia	EPANL2X4 5400LM 80CRI 35K MIN1 ZT MVOLT	2'x4' flat panel (DAO)	UNV	1	49	LED 5400	1	DLD	RC	Ceiling Height	
RC4E	Lithonia	EPANL2X4 5400LM 80CRI 35K MIN1 MVOLT	2'x4' flat panel	UNV	1	49	LED 5400	1	DLD	RC		
RC5	Lithonia	EPANL 2X2 4000LM 80CRI 35K MIN1 MVOLT	2'x2' flat panel	UNV	1	37	LED 4000	1	DLD	RC		
RC6	Hubbell	Existing Lighting Fixture	Existing LED 2'x4' flat panel	UNV	1	37	LED 4000	1	DLD	RC		9
RC7	Hubbell	Existing Lighting Fixture	Existing LED 2X2' flat panel	UNV	1	33	LED 4000	1	DLD	EC		9

Mark	Manufacturer	Catalog Number	Description	Volts	Lamps				Driver		Mtg. Height	Notes
					No.	Watts	Type/Lumens	No.	Type			
RC8	Hubbell	Existing Lighting Fixture	Existing LED 2'X2' flat panel	UNV	1	39	LED 4400	1	DLD	RC		9
RC9	Lithonia	EPANL 2X2 4000LM 80CRI 35K MIN 1 EZT MVOLT	2X2' flat panel	UNV	1	33	LED 4000	1	DLD	EC		
RC10	Lumenwerx Focal Point Finelite Axis Lighting Spectrum	VIA4R-D-WDO-FH-SW-80CRI-1500LMF-35K-XX-UNV-D1-1C-TGX-W FSM4 series HP-4R series B4RLED series	4" LED recessed linear slot	UNV	1	13.8 per 4'	LED 1500	1	DLD	RC		3,6,7
RC11	Spectrum	RWFORXT-20L-35HK-WD-DO1O-1-RW4FXT-XX-SKX	4" wall washer fixture	UNV	1		LED		DLD	RC		
RD1	Spectrum	SGDF6LEDOS-10L-30K-DS10-2-AR6160DFOS-MW	4" round downlight wet location listed	277	1	11	LED 1100	1	DLD	SC		3,6
RD2	Lithonia Maxilume Prescolite Halo	LDN4-35/15-LD4AR-LSS-MVOLT-EZ10-TRW HH4 series LF series HC4 series	4" LED round downlight	UNV	1	17.5	LED 1512	1	DLD	RC		3,6
RD3	Gotham	IVO4S-D-15LM-35K-80CRI-MD-MIN10-MVOLT-EZT-ICAT	4" LED round downlight; 2" max height low profile; IC-rated; wide optics; maintainable from below ceiling	UNV	1	15.7	LED 1500	1	DLD	RC	Clg Hgt	3,6
RD3A	Gotham	IVO4S-D-20LM-35K-80CRI-MD-MIN10-MVOLT-EZT-ICAT	4" LED round downlight; 2" max height low profile; IC-rated; wide optics; maintainable from below ceiling	UNV	1	22.4	LED 2000	1	DLD	RC	Clg Hgt	3,6
RD4	Lithonia Lighting	LDN6RV-35/20-LR-6-XX-LD-MVOLT-GZ10-LH	6" diameter LED remodel/refrofit maintainable from below ceiling (DAO)	UNV	1	23	LED 2000	1	DLD	RC	Ceiling Height	3,6
SC1	Lithonia	(BLPW4-60L-SDP-GZ10-LP835-JOTVTX15-DIM10)	Linear surface fixture with integral controls	UNV	1	49	LED 5400	1	DLD	SC	Ceiling Mounted	

Mark	Manufacturer	Catalog Number	Description	Volts	Lamps			Driver		Mtg. Height	Notes
					No.	Watts	Type/Lumens	No.	Type		
SC2	ConTec	TLT24V13K12R – TLP24VHW60MVD2-ENC – TLACS6- TLACSE2 – TLALC6	Standard output 24VDC cut in field tapelight for existing display cases with mounting channel and frosted lens. Provide fixture lengths, mounting channel, end caps, mounting accessories and power supplies as required	24V	1	2.1/Ft	LED/248 per Ft	1	DLD	SC	3,6,7
SW1	Lithonia	OLVTWM	Vaportite LED	UNV	1	15	LED 600	1	LD	SW	3

Driver & Ballast Legend	
Symbol	Description
DLD	Dimming LED Driver, 0-10 volts.
LD	LED driver.
SD	Step Dimming
PCD	Phase Cut Dimming

Mounting Legend			
Symbol	Description	Symbol	
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	G	Ground Mounted
WB	Wall Bracket	B	Bollard

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.
----	---

Luminaire Notes	
1	Provide stem/chain size as required.
2	Provide single or double faces with or without Chevron as shown on Drawings.
3	Provide all additional mounting accessories, including chain hung where applicable, for each application.
4	Provide lengths as shown on the drawings.
5	Provide aircraft cable to mount at bottom of steel.
6	Architect to select finish of luminaire. All standard (non-custom chip matching) color options should be included in Base Bid. 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 custom pendant lengths as directed by the Architect.
9	Existing luminaires to be installed in the new ceiling. Thoroughly clean and rewire and/or re-program controls.
10	Provide a base per for mounting luminaire.
11	Coordinate setback from flagpole/sign/building with the Engineer before rough-in.
12	Provide chain to hang fixture at height indicated. Coordinate with ductwork and piping to avoid light distribution blockage by ductwork and piping.
13	Provide 100W equivalent A19 3000K dimmable replacement lamps. Provide manufacturer label on luminaire indicating use maximum 14W replacement lamps.

END OF SECTION 265200

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.
 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.
 - 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.
 - 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).
- 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

SECTION 260924 – OCCUPANCY SENSORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Occupancy Sensors

1.2 REFERENCE

- 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 in the system.
 - c. Data sheets of all items to be provided with the specific item or model number highlighted.
 - d. Interconnection wiring diagrams.
 - e. Load restrictions for each device when used with electronic ballasts.
 - f. Overall lighting plan clearly marked by manufacturer showing proper product, location, and orientation of each sensor.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of each occupancy sensor in project record documents.
- C. Operation Data:
 - 1. Instructions for operating lighting control system.
 - 2. Instructions for operating system under unusual conditions when emergency life safety conditions exist.
 - 3. Operating limits which may result in hazardous or unsafe conditions, or in equipment damage.
 - 4. Document ratings of system and of each major component.
- 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.

1.5 QUALITY ASSURANCE

- 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.

1.6 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.

1.7 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

1.8 SYSTEM DESCRIPTION

- A. The objective of this section is to ensure the proper installation of the occupancy-sensor based lighting control system so that lighting is turned off automatically after reasonable time delay (minimum 15 minutes) when a room or area is vacated by the last person to occupy said room or area.
- B. The occupancy-sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits.

1.9 SYSTEM OPERATION

- A. It shall be the contractor's responsibility to make all proper adjustments to assure Owner's satisfaction with the occupancy system.

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. Wall Switches: 1 for every 10 of each type installed. Furnish at least 1 of each type installed.
 2. Occupancy Sensors: 1 for every 20 of each type installed. Furnish at least 2 of each type installed.

1.11 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Wall switch sensors shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet.
- B. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180° coverage capability.
- C. Wall switch products shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
- D. Wall switch sensors shall have no leakage current to load, in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.
- E. Dual technology sensors shall be either corner mounted or ceiling mounted in such a way as to minimize coverage in unwanted areas.
- F. Dual technology shall consist of passive infrared and ultrasonic technologies for occupancy detection. Microphonics Equipment shall be acceptable equals.
- G. Ultrasonic sensors shall utilize Advanced Signal Processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and airflow throughout controlled space.
- H. Ultrasonic operating frequency shall be crystal controlled at 40 kHz \pm 0.002% tolerance to assure reliable performance and eliminate sensor crosstalk. Sensors using 32 kHz or multiple frequencies are not acceptable.
- I. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
- J. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
- K. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
- L. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.

- M. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
- N. All sensors shall have UL rated, 94V-0 plastic enclosures.

2.2 SINGLE BUTTON AUTOMATIC WALL SWITCH

- A. Manufacturers:
 - 1. Watt Stopper Model DW-100
 - 2. Sensor Switch Model WSX-PDT-XX
 - 3. Leviton Model OSSMT-MDX
 - 4. Lutron Model MSX102-XX

2.3 TWO BUTTON AUTOMATIC WALL SWITCH

- A. Manufacturers:
 - 1. Watt Stopper Model DW-200
 - 2. Sensor Switch Model WSX-PDT-2P-XX
 - 3. Leviton Model OSSMD-MDX
 - 4. Lutron Model MSX202-XX

2.4 0-10V DIMMING WALL SWITCH OCCUPANCY SENSOR

- A. Manufacturers:
 - 1. Watt Stopper Model DW-311-X
 - 2. Hubbell Model LHDMMTS-2-N-XX
 - 3. Sensor Switch Model WSX-PDT-D-XX

2.5 CIRCUIT CONTROL HARDWARE - CU

- A. Control Units - For ease of mounting, installation and future service, control unit(s) shall be able to externally mount through a 1/2" knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Control unit shall provide power to a minimum of 2 sensors.
- B. Relay contacts shall have ratings of:
 - 1. 20A - 120 VAC Ballast
 - 2. 20A - 277 VAC Ballast
- C. Control wiring between sensors and controls units shall be Class II, 18-24 AWG, stranded UL Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.
- D. Minimum acceptable wire gauge from the circuit control hardware relays shall be #14 AWG.
- E. Provide power packs as required for all sensors. All power packs shall be universal voltage.

2.6 PROTECTIVE CAGES

- A. Manufacturers:
 - 1. Watt Stopper Model WC-1, WC-2, WC-3, or WC-4
 - 2. Sensor Switch Model WG1, WG2, WG3, or WG4
 - 3. Leviton Model OSWCG-W, OSWWG-W, OSWWG-POW, OSWCG-POW, OSFCG-W, or ODCCG
- B. Provide protective cages for all devices located in the Gymnasium and other areas shown on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have 90% to 100% coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.
- B. Time delays shall be set to a fixed interval of 15 minutes, minimum. In some cases, this may need to be increased, depending upon the use of the space.
- C. It is the contractor's responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at Owner's facility, to verify placement of sensors and installation criteria.
- D. Proper judgment must be exercised in executing the installation to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The Contractor shall also provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment and problem-solving diagnosis of the occupancy sensing devices and systems.
- E. Wiring Methods:
 - 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.

3.2 SETUP

- A. Provide dip switch setting for the following setup.
- B. Single button automatic wall switch:
 1. On – manual
 2. Off – sensor (15-minute delay)
- C. Two button automatic wall switch:
 1. On – manual
 2. Off – sensor (15-minute delay)
- D. 0-10V dimming wall switch occupancy sensor:
 1. On – manual
 2. Off – sensor (15-minute delay)

3.3 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 1-hour session to demonstrate equipment.
 3. Provide documentation of sessions to Architect/Engineer with signatures of at least 3 Owners Representatives present at demonstration.

END OF SECTION 260924

SECTION 260940 – DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Digital Lighting Controls

1.2 REGULATORY REQUIREMENTS

- 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 20 – General Use Switches, Plug Load Controls
- F. UL 924 – Standard for Emergency Lighting and Power Equipment

1.3 DESIGN / PERFORMANCE REQUIREMENTS

- A. Digital Lighting Management System shall accommodate the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories 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. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
- e. Show exact location of all digital devices, including at minimum sensors, room controllers, and switches for each area on reflected ceiling plans. (Contractor must provide AutoCAD format reflected ceiling plans.)
- f. 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.
 - 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.
 - 2. Relative humidity: Maximum 90%, non-condensing.

1.10 WARRANTY

- A. Provide the warranty specified in Section 260010.

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. Occupancy Sensors: Furnish at least 5 of each type installed.
 - 2. Wall Switches: Furnish at least 5 of each type and finished installed.
 - 3. Daylight Sensors: Furnish at least 2 of each type installed.
 - 4. Room Controllers: Furnish at least 2 of each type installed.
 - 5. Pre-terminated patch cables: Furnish 5 of each type/length installed.

1.12 MAINTENANCE MATERIALS

- A. Furnish one wireless configuration tool.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Current – NX Lighting Controls System
 - 1. No equals approved. New equipment to match existing to remain equipment.

2.2 SYSTEM ARCHITECTURE

- A. System shall consist of wired and/or wireless, distributed intelligent lighting control devices consisting of but not limited to control modules with ON/OFF, full range dimming and CCT

control capabilities, and system input devices including but not limited to occupancy/vacancy sensors, daylight sensors and manual switch stations.

- B. System shall provide for automatic self-configuration of system devices. Self-configuration shall be accomplished by the devices themselves and provide for control of lighting prior to system custom configuration and programming. Systems that require configuration prior to use shall be considered unacceptable.
- C. To implement lighting control strategies, the system architecture shall facilitate the association of system input devices to control modules. The system shall use the Area/Zone/Group assignment strategy. The system shall support up to 128 Areas. Each area shall consist of up to 128 Zones and each zone shall consist of up to 16 Groups. Each device may be programmed to participate in one Area and Zone however may belong to one or more of the available 16 Groups within a Zone.
- D. System shall provide time-of-day and astronomical clock scheduling. Each Area/Zone shall support up to 99 scheduled events for use in developing time-of-day or astronomical clock sunrise/sunset automated schedules. Each schedule shall have the ability to turn a group ON or OFF or activate a preset lighting scene at a scheduled time. Schedules shall be day-of-week selectable and may be programmed to activate on any combination of days of the week (Sunday through Saturday) or to activate on a specific date/holiday.
- E. System shall support blink alerts. Relay outputs within the control modules shall be programmable to blink prior to being turned OFF. Blink alert duration time shall be adjustable. Control modules programmed for the blink alert function shall blink the controlled lighting prior to turning OFF to warn occupants of the upcoming OFF event. If an ON command is received during the blink alert time, relay output will be overridden and left ON for the override time. Override time shall be adjustable.
- F. System input devices shall be deployed in a space to monitor and broadcast changes such as occupancy, daylight levels and manual switch input.
- G. System customization and programming shall be performed from a mobile App and/or web-based configuration and system management tools.
- H. System shall have an intuitive and easy to use Graphical User Interface (GUI) to configure, control, monitor and schedule individual devices or groups of devices.
- I. System shall remain fully functional during the programming process. Lighting control systems that must be taken "OFFLINE" for programming are not acceptable. All programming changes shall take effect immediately as they are programmed.
- J. System shall be capable of being accessed from a local network or remotely using any standard Internet browser. System shall not require any special client-side software. Systems which utilize special client-side software shall not be acceptable.
- K. Systems devices shall be capable of communication with each over one or all of the below methods.
 - 1. RS485 multidrop serial network

2. Wireless mesh network
 3. Ethernet TCIP network
- L. Wired – RS485/Ethernet
1. System shall provide an Ethernet communication backbone (NX Network) for the connection of control Zones.
 2. System shall utilize the RS485 standard for connection of and communications between Zone Devices.
 3. System shall utilize the RS485 standard for connection of and communications between SmartPORT™ devices (e.g., Sensors, Switches and Accessories) connected within a NX Zone.
- M. Wireless – Coordinator-less, Self-Organizing/Self-Healing Mesh
1. System shall have a wireless architecture that utilizes wireless mesh radio technology to create a peer-to-peer, self-organizing and self-healing mesh network infrastructure.
 2. System shall have no single point of failure. A master controller/coordinator or master node shall not be required for proper system operation. All nodes shall be capable of communicating with each other without the need of these types of single point of failure devices. Systems which utilize a master controller/coordinator shall not be acceptable.
 3. System shall be self-organizing. The mesh network of devices shall self-organize automatically without the need to manually set device addresses via dials, DIP switches or other means.
 4. System shall be self-healing. System devices within the mesh network shall automatically reroute messages around a failed device to ensure message delivery.
 5. System architecture shall facilitate data transmission between wireless devices over the 2.4GHz ISM radio frequency (RF) band with a supported RF range of 100ft between wireless devices indoors and 300ft outdoors.
 6. System shall use a wireless mesh radio communication protocol to transmit/receive and negotiate messaging among wireless devices.
 7. System shall utilize spread spectrum frequency hopping to facilitate robust communication and prevent the unauthorized interception of messages over the air and to comply with FCC requirements.
 8. System shall provide the ability to secure messages. When implemented, each device shall use the strong and secure AES-128 (Advanced Encryption Standard) security cipher to encrypt and decrypt messages. System shall also use the secure HTTPS/SSL protocol when users access the system using their Internet browser.
- N. System devices shall be capable of having their firmware updated or upgraded over the air through the wireless mesh network.

2.3 DIGITAL ROOM CONTROLLERS

- A. NX Room Controllers
1. Basis of Design Product: NX Lighting Controls System, NX Room Controllers.
 2. As indicated and where shown on the plans, install NXRC series Room Controller(s) to control the quantity of lighting and plug loads required.

3. NX Room Controller(s) shall integrate the functionality of connected control components including wall switch stations, occupancy sensors and daylight sensors to provide the required sequence of operation for the space.
4. NX Room Controller(s) and associated room control components shall operate in a totally standalone mode and not require the use of a network, software, computer, or server for local control functions.
5. NX Room Controller(s) shall have an embedded Time Clock and be capable of storing and running up to 99 local schedules. Schedules shall run autonomously without the need of any coordinator, gateway, or master controller.
6. Construction:
 - a. NX Room Controller housing shall be constructed of GSM UL rated 94 HB plastic approved for use in a return air plenum.
 - b. The housing and shall include an integral 1/2" chase nipple for external mounting to standard junction box knockout.
 - c. Two RJ45 FX Port connectors shall be accessible on the side of the enclosure for expansion of a Zone Segment to allow for an expanded number of Zone Segment devices (e.g., Room Controllers, In-Fixture Modules, and Digital Sensors). Up to 32 controllers and devices can be daisy-chained together.
 - d. Two RJ45 SmartPORT™ connectors shall be accessible on the side of the enclosure for the connection of NX room level devices.
 - e. Two recessed push buttons and associated LED indicators shall be accessible on the top of the enclosure to provide override, status, setup, and testing functions.
7. Electrical:
 - a. NX Room Controller(s) shall have a single power feed and shall be capable of operation at voltages between 120/277/347 volts AC, 50/60 Hz.
 - b. One or two output relays (model specific) shall provide for the following load types and ampacity (per relay):
 - 1) 20A, Tungsten,
 - 2) 20A, Magnetic Ballast,
 - 3) 16A, Electronic Ballast,
 - 4) 1 H.P. Motor @ 120V, ¾ H.P. @ 277V; ½ H.P. @ 347V
 - c. Where indicated provide one or two independent 0-10 volt dimming channels (model specific) for full range dimming control of fixtures equipped with compatible dimmable ballast or driver.
 - d. Each dimming output shall have a current sinking capacity of at least 30 mA.
 - e. NX Room Controller(s) shall be capable of supplying 250 mA of Class 2 auxiliary DC power for use by wall switch stations, occupancy sensors, and daylight sensors connected to the room controller's two RJ45 SmartPORT connectors.
 - f. NX Room Controller(s) shall be equipped with power monitoring circuitry capable of measuring and reporting the total connected load for each room controller.
8. Functional:
 - a. Provide an integral pushbutton and LED indicator for each load for status and to allow operation of the relays and dimmers for testing and verification without requiring other control devices to be connected.
 - b. NX Room Controller(s) shall have a default operation providing an automatic logical sequence of operation for each load as the room control devices are plugged into the SmartPORT connectors.

- c. Default operation for occupancy sensors shall be automatic on, automatic off for all loads.
- d. Upon connection of a switch, the operation shall automatically change to manual on, automatic off (vacancy) mode for all loads.
- e. Provide capability to convert each load independently to automatic on or vacancy mode using only the integral push buttons and LED indicators on the room controller.
- f. When in vacancy mode, provide a 30 second grace period after an off during which automatic on shall be temporarily enabled.
- g. It shall be possible to connect up to thirty-two (32) room controllers together on the FX Ports using Cat5 patch cables to provide configurations up to 64 switched and dimmed loads operating as a single zone.
- h. Provide the following set up and configuration functions without the need for additional devices or software:
 - 1) Assign/reassign relays for control by wall switch station buttons,
 - 2) Configure relays for occupancy or vacancy operation,
 - 3) Assign/reassign dimmers to raise/lower switches,
 - 4) Assign dimming channels for response to daylight sensor control,
 - 5) Auto calibrate default daylight sensor sequence of operation,
 - 6) Save preset scenes.
- 9. NX Room Controller(s) shall support the following specialty modes:
 - a. SpectraSync™ CCT Control
 - 1) Dimmer channels can be set individually to control CCT via 0-10V.
 - 2) Scheduling can be implemented to mimic the natural transition of light throughout the course of the day.
 - 3) Room-based solutions can be implemented to allow occupants to tune color to task.
 - b. SpectraClean™
 - 1) Ability to control SpectraClean enabled fixtures with three different modes for varying applications:
 - a) Constant On
 - b) Scheduled
 - c) Programmed Dosage

2.4 UL924 LOAD CONTROLLER

A. NX UL924 Load Controller

- 1. Basis of Design Product: NX Lighting Controls System, NX UL924 Load Controller.
- 2. As indicated and where shown on the plans, install NX UL924 Load Controller to control the quantity of emergency lighting loads required.
- 3. NX UL924 Load Controller shall meet NFPA Article 700 requirements for emergency lighting.
- 4. NX UL924 Load Controller and associated room control components shall operate in a totally standalone mode and not require the use of a network, software, computer, or server for local control functions.
- 5. NX UL924 Load Controller shall provide a remote test button or fire alarm interface.

6. NX UL924 Load Controller shall have an embedded Time Clock and be capable of storing and running up to 99 local schedules. Schedules shall run autonomously without the need of any coordinator, gateway, or master controller.
7. Construction:
 - a. NX UL924 Load Controller housing shall be constructed of GSM UL rated 94 HB plastic approved for use in a return air plenum.
 - b. The housing shall include an integral 1/2" chase nipple for external mounting to standard junction box knockout.
 - c. Two RJ45 FX Port connectors shall be accessible on the side of the enclosure for expansion of a Zone Segment to allow for an expanded number of Zone Segment devices (e.g., Room Controllers, In-Fixture Modules, and Digital Sensors). Up to 32 controllers and devices can be daisy-chained together.
 - d. Two recessed push buttons and associated LED indicators shall be accessible on the top of the enclosure to provide override, status, setup, and testing functions.
8. Electrical:
 - a. NX UL924 Load Controller shall have a single power feed and shall be capable of operation at voltages between 120/277/347 volts AC, 50/60 Hz.
 - b. One relay output shall provide the following load types and ampacity:
 - 1) 20A, Tungsten,
 - 2) 20A, Magnetic Ballast,
 - 3) 16A, Electronic Ballast,
 - 4) 1 H.P. Motor @ 120V, ¾ H.P. @ 277V; ½ H.P. @ 347V.
 - c. NX UL924 Load Controller shall provide two independent 0-10 volt dimming channels for full range dimming control of fixtures equipped with compatible dimmable ballast or driver.
 - d. Each dimming output shall have a current sinking capacity of at least 30 mA.
 - e. NX UL924 Load Controller shall be equipped with power monitoring circuitry capable of measuring and reporting the total connected load for each room controller.
9. Functional:
 - a. SmartPORT Functionality:
 - 1) NX UL924 Load Controller shall automatically recognize connected devices in the Zone Segment.
 - 2) NX UL924 Load Controller shall function as a standard room controller.
 - 3) NX UL924 Load Controller's RJ45 CAT5 connection shall be used as a sensing line to standard room controller only and does not support NX room devices.
 - b. Emergency Functionality:
 - 1) NX UL924 Load Controller's RJ45 CAT5 connection shall be used as a sensing line to standard room controller on normal circuit.
 - 2) Removal of 24VDC on CAT5 connection shall put NX UL924 Load Controller into emergency state.
 - 3) NX UL924 Load Controller's default emergency state is ON with both dimming channels to 100%
 - c. Provide an integral pushbutton and LED indicator for controlled load for status and to allow operation of the relay and dimmers for testing and verification without requiring other control devices to be connected.
 - d. Provide the following set up and configuration functions without the need for additional devices or software:

- 1) Assign/reassign relays for control by wall switch station buttons,
 - 2) Configure relays for occupancy or vacancy operation,
 - 3) Assign/reassign dimmers to raise/lower switches,
 - 4) Assign dimming channels for response to daylight sensor control,
 - 5) Save preset scenes.
10. NX UL924 Load Controller shall support the following specialty modes:
- a. SpectraSync™ CCT Control
 - 1) Dimmer channels can be set individually to control CCT via 0-10V.
 - 2) Scheduling can be implemented to mimic the natural transition of light throughout the course of the day.
 - 3) Room-based solutions can be implemented to allow occupants to tune color to task.
 - b. SpectraClean™
 - 1) Ability to control SpectraClean enabled fixtures with three different modes for varying applications:
 - a) Constant On
 - b) Scheduled
 - c) Programmed Dosage

2.5 FIXTURE MODULES

A. NX In-Fixture Modules

1. Basis of Design Product: NX Lighting Controls System, NX In-Fixture Modules.
2. As indicated in the specifications and as shown on the plans, install NXFM series Fixture Control Module enabled fixture(s).
3. NX In-Fixture Modules shall be designed to install inside the fixture they control.
4. NX In-Fixture Modules shall consist of a completely distributed intelligent lighting controller capable of functioning completely independently including time based and astronomical scheduling of On/Off and preset events without the need of any coordinator, gateway or master controller. Sensors and switches as well as other NX In-Fixture enabled fixtures shall be capable of being connected directly to the NX In-Fixture Module to create a fully functional lighting control system.
5. NX In-Fixture Module shall be provided with one SPST relay. Relay shall be supplied with "Zero Cross Switching" control to limit the effects of inrush on the relay contacts.
6. NX In-Fixture Module shall be compatible with incandescent, magnetic, and electronic lighting loads including LED drivers. NX In-Fixture Module shall include zero arc point switching circuitry and have the following max load ratings:
7. Construction:
 - a. Housing: GSM UL Rated 94 HB Plastic
 - b. Mounting: Mounts inside fixture
8. Electrical:
 - a. Line Voltage Versions:
 - 1) Input: Universal 120-347VAC, 50-60Hz
 - 2) Output: One or two relay outputs (model specific) shall provide for the following load types and ampacity (per relay):
 - a) 10A, 120VAC only Incandescent
 - b) 10A, 120-347VAC, Magnetic Ballast
 - c) 5A, 120-277VAC, Electronic Ballast

- d) 3A, 347VAC, Electronic Ballast
 - 3) Surge Withstand: 2000V
 - 4) Peak Inrush: 160A for 2 ms Max
 - b. Low Voltage Versions:
 - 1) Input: 12-24VDC
 - c. NX In-Fixture Modules shall be provided with two 0-10VDC control interfaces for full range dimming control of dimming ballasts and LED drivers. Interface shall be designed to continuously sink 30mA of current.
 - d. NX In-Fixture Module 0-10VDC control interfaces shall be configurable for 0-10VDC dimming, dim to off or color temperature control.
9. Functional:
- a. NX In-Fixture Modules shall be designed to self-configure, automatically to meet energy code requirements as NX sensors and other NX devices are connected.
 - b. NX In-Fixture Module shall be designed such that self-configuration takes place automatically without user intervention or commissioning of any kind.
 - c. NX In-Fixture Modules shall be rated and tested for an operating temperature range of -40° to 185°F [-40° to 85°C].
 - d. NX In-Fixture Module shall be equipped with a Real Time Clock and integral backup for schedule information. Each module shall support up to 99 schedules. Schedules shall be loaded to the module via the network or locally using the NX Lighting Controls App. Once loaded, schedules shall run autonomously without the need of any coordinator, gateway, or master controller.
 - e. NX In-Fixture Module shall be capable of having its device firmware updated wirelessly over the air when connected to a NX sensor or via the NX SmartPORT.
 - f. NX In-Fixture Modules shall be supplied with one momentary pushbutton with LED for manual control and testing. Through the use of this switch, it shall be possible to test the On/Off and dimming functionality of the NX In-Fixture module or completely reset the NX In-Fixture Module to factory defaults without the need to connect any other device or testing equipment.
 - g. NX In-Fixture Module shall include non-volatile memory for retaining device settings during power outages.
10. NX In-Fixture Module shall be UL Listed to UL916 and Certified to CAN/CSA C22.2 NO 205-M1983.
11. NX In-Fixture Module shall be FCC certified.
- B. NX On-Fixture Modules
- 1. Basis of Design Product: NX Lighting Controls System, NX On-Fixture Module.
 - 2. As indicated in the specifications and as shown on the plans, install NXOFM series wireless On-Fixture Control Module(s).
 - 3. NX On-Fixture modules shall consist of a completely self-contained distributed intelligent wireless lighting controller capable of functioning completely independently including time based and astronomical scheduling of On/Off and preset events without the need of any coordinator, gateway or master controller.
 - 4. NX On-Fixture Module shall be configurable remotely over the air utilizing built in Bluetooth radio an iOS or Android handheld device with the NX Lighting Controls App installed or via NX Wireless Network.

5. NX On-Fixture Module shall be capable of having its device firmware updated wirelessly over utilizing it's built in Bluetooth radio and iOS or Android handheld device with the NX Lighting Controls App installed or via NX Wireless Network.
6. On-Fixture Module shall respond to scheduled events, occupancy/vacancy sensor events and manual switch station events.
7. On-Fixture Module shall monitor and measure energy consumption.
8. On-Fixture Module shall include non-volatile memory for retaining device settings during power outages.
9. NX On-Fixture Modules shall be rated and tested for an operating temperature range of -40° to 185°F [-40° to 85°C].
10. NX On-Fixture Module shall include one SPST relay for On/Off control.
11. NX On-Fixture Modules relay shall be supplied with "Zero Cross Switching" control to limit the effects of inrush on the relay contact.
12. NX On-Fixture Module shall be compatible with incandescent, magnetic, and electronic lighting loads including LED drivers.
13. Construction:
 - a. Housing: GSM UL Rated 94 HB Plastic
 - b. Mounting: Standard C136-41 (2013) with 5 or 7 pin twist-lock connector. Compatible with C136-10 sockets.
14. Electrical:
 - a. Input: 120-480VAC, 50-60Hz
 - b. Output: Relay output shall provide for the following load types and ampacity:
 - 1) 5A@120-347VAC,
 - 2) 3A@480V
 - c. Surge Withstand: 2000V
 - d. Peak Inrush: 160A for 2 ms Max
 - e. Standby Power (W):
 - 1) 120VAC: 1.2
 - 2) 277VAC: 1.5
 - 3) 347VAC: 1.5
 - 4) 480VAC: 1.3
15. Functional:
 - a. On-Fixture Module shall include an integrated daylight sensor with a foot candle range as shown below:
 - 1) On level: 1FC to 5FC (Default: 5FC)
 - 2) Off level: 4FC to 15FC (Default: 8FC)
 - b. NX On-Fixture Modules shall communicate with other NX enabled fixtures and devices via NX Wireless Network with the following characteristics:
 - 1) Robust & reliable IEEE 802.15.4 2.4GHz wireless self-organizing and self-healing mesh network
 - 2) Radio Range: Outdoor: ~1000 ft. (~300m) Note: Range based on clear line of site.
 - 3) Security: AES-128 (Advanced Encryption Standard)
16. NX On-Fixture Module shall include non-volatile memory for retaining device settings during power outages.
17. NX On-Fixture Module shall UL Listed to UL916 and Certified to CAN/CSA C22.2 NO 205-M1983.
18. NX On-Fixture Module shall be FCC certified.

2.6 LIGHTING CONTROL PANELS

A. NX Lighting Control Panels

1. Basis of Design Product: NX Lighting Controls System, NX Lighting Control Panels.
2. As indicated and where shown on the plans, install NX Lighting Control Panels V2 (NXP2 Series).
3. Panel shall be a fully distributed intelligent lighting controller with the ability to function as a stand-alone lighting control panel or as part of an NX networked system.
4. Panel shall provide standard capacities for 8, 16, 24, 32, or 48 relays in each panel with matching number of 0-10v dimming channels.
5. Panel shall be available in custom configurations. Configuration options shall include: panel shipment type (enclosure/interior shipped together, enclosure/interior shipped separately, enclosure only, and interior only), panel size, number of single pole/double pole relays, emergency control option, input voltage and enclosure mount (surface mount or flush mount).
6. Panels shall be factory assembled and tested. No field assembly shall be required.
7. Construction:
 - a. Panel shall be surface or flush wall mounted in a NEMA1 rated enclosure, based on panel configuration.
 - b. Panel shall be capable of being shipped with enclosure/interior together, enclosure/interior separately, enclosure only, and interior only in appropriately designed packaging. When enclosure is shipped separately, enclosure shall enable rough-in of all electrical connections prior to receipt of the panel interior.
 - c. Panel enclosure shall have standard electrical conduit knockouts on the top, the bottom and both sides of the enclosure to allow installation flexibility. Field drilling and cutting for pipe and wire shall not be required.
 - d. Panel shall provide keyhole mounting holes in the rear of the enclosure.
 - e. Panel enclosure shall include 6" spacing running the width of the panel at the bottom of the panel to allow for line voltage accessories such as contactors or to provide a "gutter". Space shall be separated from the low voltage area utilizing a removable metal barrier. No knockouts added to the bottom plate of the inner high voltage divider. Exterior enclosure will maintain knockouts on bottom.
 - f. Panel venting shall conform to NEMA 1 enclosure specifications to contain any local explosion and to protect the working environment.
 - g. Panel enclosure shall feature removable metal barriers that separate all high-voltage components and wiring (Class 1) from all low-voltage (Class 2) components and wiring.
 - h. Panel enclosure shall be of welded construction primed and painted with a powder coat finish. Unpainted or galvanized enclosures are not acceptable.
 - i. Panel cover shall attach to the enclosure with #10-32 x ½" truss head machine screws.
 - j. Panel cover shall employ "keyhole" style openings for the top two mounting screws to allow the panel's cover to be temporarily hung during installation eliminating the need to completely remove all the mounting screws along with contributing to safety ensuring the cover does not swing if all screws were removed.
 - 1) 8 Relay panel cover – 4 mounting holes: 2 keyhole style slots, 2 slotted style slots

- 2) 16/32 Relay panel cover – 6 mounting holes: 2 keyhole style slots, 4 slotted style slots
- 3) 48 Relay panel cover – 8 mounting holes: 2 keyhole style slots, 6 slotted style slots
- k. Panel cover shall be sized for either surface or recess mounting of the panel.
- l. Panel cover shall have hinged locking door to expose only the low voltage wiring section of the panel.
- m. Panel door hinges shall be located on the left side.
- n. Panel shall be provided with a factory or field installable panel interior. Panel interior shall contain all controller electronics, power supplies, relays, and other required components. Panel shall arrive at the project site completely pre-wired and requiring only the connection of lighting circuits and network cable. Systems that require field assembly of controllers or chassis inserts are not acceptable
- o. Panel interior components shall reside on a framed skeleton. When disconnected from the load circuits and necessary mounting connections, the framed skeleton can be removed taking all the electrical components intact.
- p. Panel interior components shall be designed to not become dislodged during shipment.
- q. Panel spacing between panel relays shall be suitable for separating any two relays in the panel to meet the NEC requirements for normal and emergency power when a metal divider is installed between relays. A metal plate barrier shall be available to separate relays - two plates per application.
- r. Panel relays shall be of the snap-in type and be individually field replaceable.
- 8. Electrical:
 - a. Panel shall be supplied with either a 120V/277V, 347V or 480V power supply.
 - b. Panel power supply shall provide the required capacity for the operation of the panel, relays, controllers, NX Network, SmartPORTs, user interfaces and the maximum number of low voltage and/or data devices that can be connected to each panel.
 - c. Panel wire connections shall be made to labeled terminal blocks.
 - d. Panel shall have LED status/failure indicators.
 - e. Panel shall provide support for Bluetooth programming using the NX Lighting Controls App and the NX Bluetooth Radio Bridge with Clock or a SmartPORT connected NX sensor.
 - f. Panel shall include two (2) Ethernet ports for connection to the NX Network.
 - g. Panel shall include four (4) RJ45 NX SmartPORTs for the connection of all NX sensors and switches. SmartPORTs shall be capable of supplying 250 mA of Class 2 auxiliary DC power for use by wall switch stations, occupancy sensors, and daylight sensors connected to the SmartPORT connectors
 - h. Panel shall have four (4) 3-wire low voltage dry contact inputs. Removable terminal blocks shall be provided to support momentary or maintained closures from building automation systems, fire systems, demand response and security systems as well as other systems or devices including occupancy sensors, daylight sensors, and low voltage switches. Each input shall be individually programmable and provide the ability to initiate any NX switch compatible function or command. (on, off, raise, lower, preset, timed on/off). Each input will provide a connection for sourcing 24V, a common, control and pilot light functionality for low voltage switch stations.

- i. Panel shall have two (2) SPDT (NO/NC) dry contact outputs, with removable terminal blocks, to provide a contact closure to signal out to another system that is capable of receiving a NO or NC closure to signal building automation, security or alarm system based on a schedule or a command from an input device (e.g. occupancy sensor, daylight sensor, wall switch station, etc.). Each output will have a contact rating of 24VDC@50mA minimum.
- j. Panel shall have an easily accessible, removable coin size battery for maintaining system time during a power loss.
- k. Panel shall, after a power loss, retain time for a minimum of 72 hours.
- l. Panel time shall be updated when connected to a device utilizing the NX Lighting Controls App or from an NX network time server.
- m. Panel shall feature a power sensing circuit and transformer for UL924 operation. Upon detection of loss of power, the panel shall force all relays closed and all dimming channels to full bright. Panel shall maintain this state until normal power is restored. Connected devices will not be powered.
- n. Panel shall have a test button on the optional UL924 board to test the UL924 operation.
- o. Panel shall have a low voltage remote test switch input on the optional UL924 to test the UL924 operation.
- p. Panel shall provide relay/dimmer boards to expand panel capacity from 8 to 48 relay outputs in groups of 8. Relay/dimmer boards shall be completely self-configuring and shall not require manual settings to configure for use within the panel.
- q. Panel relay/dimmer boards shall confirm relay presence and status.
- r. Panel relay/dimmer boards shall have (8) 0-10V integrated dimming channels, each capable of sinking 50mA.
- s. Panel dimming channels shall be software assignable.
- t. Panel shall be capable of containing 1 to 48 robust and reliable mechanically latching lighting control relays as indicated on the drawings and schedules as specified herein. Electrically held or non-mechanically latching relays shall not be considered.
- u. Panel relays shall be individually UL and CUL listed and shall bear labels indicating compliance. Lighting control relays shall be tested to UL standard 508 for both safety and durabilities and bare labels signifying compliance.
- v. Panel relays shall have the following load ratings:
 - 1) Single Pole Relays:
 - a) General Use: 30A @ 300VAC
 - b) Tungsten: 2400W @ 120VAC
 - c) Standard Ballast: 20A @ 300VAC
 - d) Motor Starting: 1HP @ 110-125VAC; 1½ HP @ 220-277VAC
 - 2) Double Pole Relays:
 - a) General Use: 20A @ 480VAC
 - b) Tungsten: 2400W @ 120VAC
 - c) Standard Ballast: 20A @ 480VAC
 - d) Motor Starting: 1HP @ 110-125VAC; 1½ HP at 220-277VAC
- w. Panel relays shall be rated for minimum cycle life of 120,000+ operations (60,000+ cycles).
- x. Panel relays shall have a Short Circuit Current Rating (SCCR) of 18,000A @ 277VAC.

- y. Panel relays shall have a built-in manual override lever & ON/OFF indicator.
- z. Panel relays shall be capable of manual activation On or Off with or without power.
- 9. Functional:
 - a. Panel shall be of the distributed intelligence type and shall not be dependent on a network connection to execute schedules or perform programmed functions.
 - b. Panel shall be programmed using the optional NXBTC Bluetooth® radio module with clock and NX Lighting Controls App. When networked, panel configurations shall be performed utilizing the NX Area Controller's web-browser based Graphical User Interface.
 - c. Panel shall provide the ability to update panel firmware. Firmware update process shall ensure that the complete and correct firmware (e.g. via CRC check) has been downloaded before the panel is flashed with the new firmware.
 - d. Panel set up and configuration functions shall include (but are not limited to):
 - 1) Assign/reassign relays for control by wall switch station buttons,
 - 2) Configure relays for occupancy or vacancy operation,
 - 3) Assign/reassign dimmers to raise/lower switches,
 - 4) Assign dimming channels for response to daylight sensor control,
 - 5) Assign names to relays/dimmers,
 - 6) Auto calibrate default daylight sensor sequence of operation,
 - 7) Create and save preset scenes,
 - 8) Configure wall switch button types. At a minimum, button types shall include toggle on/off with pilot, preset, on only and off only,
 - 9) Configure up to six zones of daylight harvesting per room with independent set points and time delays,
 - 10) Include or exclude loads from occupancy sensor control,
 - 11) Configure up to 16 load groups per zone,
 - 12) Configure up to 16 preset scenes per zone with independent fade times,
 - 13) Set independent power up conditions for relays and dimmers,
 - 14) Set independent occupied and unoccupied conditions for each relay and dimmer,
 - 15) Adjust dimmer high and low trim points,
 - 16) Manually control lighting loads
 - e. Panel shall provide the ability to create up to ninety-nine (99) schedules per zone. Each schedule will consist of the following:
 - 1) Event Time – Shall be configured as a specific set “Normal” time (hh:mm am/pm) or as an offset based on one of the following: Before Sunrise, After Sunrise, Before Sunset, After Sunset, Before Open, After Open, Before Close or After Close.
 - 2) Action – Task to be performed: None, Group State, or activation of a Preset.
 - 3) None – No action to perform
 - 4) Group State – The specific relay / dim level / color temp range settings, that the select group(s) of actuators should implement.
 - 5) Presets – The specific preset that should be activated.
 - f. Panel shall provide the ability to disable a schedule
 - g. Panel shall provide the ability to delete a schedule

2.7 SENSORS

- A. NX Smart Sensor Module Passive Infrared, Wireless Occupancy & Daylight Sensor
1. Basis of Design Product: NX Lighting Controls System, NX Smart Sensor Modules.
 2. As indicated in the specifications and as shown on the plans, install NXSMP series sensor module enabled fixture(s).
 3. NX Smart Sensor Module shall be designed to install directly into or on the fixture housing or lens.
 4. NX Smart Sensor Module shall integrate seamlessly into the NX Network.
 5. NX Smart Sensor Module shall have an RF frequency of 2.4GHz.
 6. NX Smart Sensor Module shall include Bluetooth and provide connection to the NX Network using the NX Lighting Controls App.
 7. NX Smart Sensor Module Occupancy/Vacancy sensor shall provide automatic or vacancy switching of lighting load(s) within an area/zone based on the presence of human activity.
 8. NX Smart Sensor Module Occupancy/Vacancy sensor shall be microprocessor controlled and utilize IntelliSCOPE™ technology to provide real-time graphical occupancy data.
 9. NX Smart Sensor Module Occupancy/Vacancy sensor shall not require any adjustments of any kind at the time of installation or during operation.
 10. NX Smart Sensor Module Occupancy/Vacancy sensor shall be powered by SmartPORT™ using plenum rated SmartPORT plug and play cables.
 11. NX Smart Sensor Module Occupancy/Vacancy sensor shall have a timer that can be adjusted manually from 1 second to 20 minutes.
 12. NX Smart Sensor Module Occupancy/Vacancy sensor sensitivity shall be adjustable from 1 to 10.
 13. NX Smart Sensor Module Occupancy/Vacancy sensor shall include non-volatile memory for retaining device settings during power outages.
 14. NX Smart Sensor Module Occupancy/Vacancy sensor shall have RED real time motion indicator LED visible from the front of the unit.
 15. NX Smart Sensor Module Occupancy/Vacancy sensor may be programmed for active and inactive times.
 16. NX Smart Sensor Module Occupancy/Vacancy sensor shall be available with the following 360° coverage patterns:
 - a. SMI/LMI – 1:1 (mounting height to radius) up to 14 feet
 - b. OMNI – 1:1.5 (mounting height to radius) up to 14 feet
 - c. LMO – 1:3 (mounting height to radius) up to 16 feet
 - d. HMO – 1:1.4 (mounting height to radius) up to 45 feet indoors / 32 feet outdoors
 17. NX Smart Sensor Module daylight sensor shall continually measure the amount of visible light under the lighting fixture to provide continuous On/Off and full range dimming control of fixture or group under its control.
 18. NX Smart Sensor Module daylight sensor shall utilize a closed loop daylight harvesting algorithm to maintain the required light level in response to changes in daylight.
 19. NX Smart Sensor Module daylight sensor shall have independently programmable ramp up and ramp down times to allow the sensor to respond quickly to decrease in daylight and respond more slowly to increase in daylight to minimize the effect of sudden changes in daylight.
 20. NX Smart Sensor Module daylight sensor shall be capable of being programmed for active and inactive times.

21. NX Smart Sensor Module daylight sensor shall include non-volatile memory for retaining device settings during power outages.
- B. NX Smart Sensor Module Dual Technology, Wireless Occupancy & Daylight Ceiling Mount Sensor
1. Basis of Design Product: NX Lighting Controls System, NX Smart Sensor Modules.
 2. As indicated in the specifications and as shown on the plans, install NXSMDT series sensor modules.
 3. NX Smart Sensor Module DT shall be designed for indoor use only and to mount directly to ceilings.
 4. NX Smart Sensor Module DT shall integrate seamlessly into the NX Network.
 5. NX Smart Sensor Module DT shall have an RF frequency of 2.4GHz.
 6. NX Smart Sensor Module shall include Bluetooth and provide connection to the NX Network using the NX Lighting Controls App.
 7. NX Smart Sensor Module DT Occupancy/Vacancy sensor shall provide automatic or vacancy switching of lighting load(s) within an area/zone based on the presence of human activity.
 8. NX Smart Sensor Module Occupancy/Vacancy sensor shall be microprocessor controlled and shall have adjustable technology detection modes including Dual Technology (Passive Infrared (PIR) and Ultrasonic (US)), Passive Infrared (PIR) only, and Ultrasonic (US) only.
 9. NX Smart Sensor Module Occupancy/Vacancy sensor shall utilize IntelliSCOPE™ technology to enable fine-tuning of the motion detection technologies using real-time Passive Infrared (PIR) and Ultrasonic (US) graphical occupancy data.
 10. NX Smart Sensor Module DT Occupancy/Vacancy sensor shall be powered by SmartPORT™ using plenum rated SmartPORT plug and play cables.
 11. NX Smart Sensor Module DT Occupancy/Vacancy sensor shall have a timer that can be adjusted manually from 1 second to 20 minutes.
 12. NX Smart Sensor Module DT Occupancy/Vacancy sensor sensitivity shall be adjustable from 1 to 10.
 13. NX Smart Sensor Module DT Occupancy/Vacancy sensor shall include non-volatile memory for retaining device settings during power outages.
 14. NX Smart Sensor Module DT Occupancy/Vacancy sensor shall have a Red Passive Infrared (PIR) and Green Ultrasonic (US) real time motion indicator LEDs visible from the front of the unit.
 15. NX Smart Sensor Module DT Occupancy/Vacancy sensor may be programmed for active and inactive times.
 16. NX Smart Sensor Module DT Occupancy/Vacancy sensor shall have the following coverage:
 - a. 1:2.75 Coverage pattern (mounting height to coverage radius)
 - b. Coverage: Adjustable up to 2,000 square feet
 - c. Recommended Mounting Height: 8ft (2.44m) with a max mounting height: 12ft (3.66m)
 17. NX Smart Sensor Module DT daylight sensor shall continually measure the amount of visible light under the lighting fixture to provide continuous On/Off and full range dimming control of fixture or group under its control.
 18. NX Smart Sensor Module DT daylight sensor shall utilize a closed loop daylight harvesting algorithm to maintain the required light level in response to changes in daylight.
 19. NX Smart Sensor Module DT daylight sensor shall have independently programmable ramp up and ramp down times to allow the sensor to respond quickly to decrease in

daylight and respond more slowly to increase in daylight to minimize the effect of sudden changes in daylight.

20. NX Smart Sensor Module DT daylight sensor shall be capable of being programmed for active and inactive times.
21. NX Smart Sensor Module DT daylight sensor shall include non-volatile memory for retaining device settings during power outages.
22. NX Smart Sensor Module DT shall be available in White, Black and Gray colors.

C. NX Occupancy Sensors, Wired

1. Basis of Design Product: NX Lighting Controls System, NX Occupancy Sensors.
2. NX Occupancy Sensors shall be ceiling or wall mounted and use dual technology (ultrasonic and passive infrared), ultrasonic and/or passive infrared (model specific) sensing technology as indicated.
3. NX Occupancy Sensors shall be Class 2 and connect to any room controller SmartPORT using a wiring adaptor and standard Cat5 patch cable.
4. NX Occupancy Sensors shall be microprocessor controlled and utilize IntelliDAPT® technology to optimize sensor behavior to adapt to space conditions and occupant usage patterns and adjust sensitivity and time delay to maximize energy savings and minimize false On and Off events
5. NX Occupancy Sensors shall be self-adaptive and not require manual calibration after installation. Digital circuitry and logic shall automatically adjust the sensitivity and time delay based on learned occupancy patterns and the environment in which the sensor is installed.
6. NX Occupancy Sensors using both ultrasonic and passive infrared (dual technology) shall operate such that detection by both technologies is required to initiate occupancy and continued detection by either technology will maintain occupancy.
7. Up to four NX Occupancy Sensors may be connected to one room controller.

D. NX Occupancy Output Interface

1. Basis of Design Product: NX Lighting Controls System, NXRO Series Occupancy Output Interface Module.
2. NX Occupancy Output Interface shall communicate the occupancy state of an NX control zone to HVAC or other building systems using a contact closure.
3. NX Occupancy Output Interface shall connect to a SmartPORT™ and provide the aggregate occupancy state of the zone as reported by one or more occupancy sensors.
4. NX Occupancy Output Interface shall mount to a standard 4 11/16" junction box.
5. NX Occupancy Output Interface shall have a removable terminal block for input connection.
6. NX Occupancy Output Interface shall be powered by NX SmartPORT.
7. NX Occupancy Output Interface shall support multiple occupancy sensors in a zone.
8. NX Occupancy Output Interface shall feature a low voltage Form-C relay for Normally Closed / Normally Open operation.
9. NX Occupancy Output Interface shall be a low voltage device: 24VDC.

E. NX Daylight Sensor, Wired

1. Basis of Design Product: NX Lighting Controls System, NXDS Series Daylight Sensor.
2. NX Daylight Sensor shall provide ambient light level information to the room controller allowing daylight responsive lighting control.

3. The system shall operate in an open loop sequence of operation reducing the amount of electric light as the quantity of daylight entering the room increases.
4. It shall be possible to configure up to six daylight zones in a room. Each zone shall be programmable to proportionally respond to the light level provided by the daylight sensor.
5. NX Daylight Sensor shall be mounted vertically or horizontally and positioned to provide an unobstructed view of the windows per the manufacturer's directions.
6. NX Daylight Sensor shall be available in indoor and outdoor models.
7. NX Daylight Sensor shall have an architecturally attractive design.
8. NX Daylight Sensor shall have a foot-candle range: 3-6,000FC

F. NX Wall Partition Sensor

1. Basis of Design Product: NX Lighting Controls System, NXWPS Series Wall Partition Sensor.
2. NX Wall Partition Sensor shall automatically signal the NX Lighting Controls System when a moveable partition has been opened or closed. This allows the two adjacent rooms to be combined or separated into individual rooms.
 - a. NX controls shall automatically reconfigure to operate in unison when rooms are combined.
 - b. NX controls shall automatically reconfigure to operate independently when the rooms are separated.
 - c. NX system shall allow for room combine scenarios with up to 16 combinable rooms.
3. NX Wall Partition Sensor shall be a low voltage device: 24VDC.

G. NX Dry Contact Closure Interface

1. Basis of Design Product: NX Lighting Controls System, NXCI Series Contact Closure Interface.
2. NX Dry Contact Closure Interface shall enable third-party devices to provide dry contact inputs to the NX Lighting Controls System.
3. NX Dry Contact Closure Interface shall provide switch activation using contact closures from external devices such as key switches, AV systems, photo-eye sensors or other low voltage Class 2 devices.
4. NX Dry Contact Closure Interface shall default to On/Off operation and can be programmed to perform alternate functions including:
 - a. Toggle On/Off
 - b. Preset
 - c. Raise
 - d. Lower
 - e. Timed On
5. NX Dry Contact Closure Interface shall feature a removable terminal block for input connection.
6. NX Dry Contact Closure Interface shall feature pilot light output terminals.
7. NX Dry Contact Closure Interface shall be a low voltage device: 24VDC.

2.8 WALL STATIONS

A. NX SimpleTouch™ Graphic Wall Station

1. Basis of Design Product: NX Lighting Controls System, NX SimpleTouch Graphic Wall Station.

2. Graphic Wall Station shall employ a 3.5" resistive LCD-TFT, full-color touch screen with 320x480 screen resolution in portrait orientation.
3. Graphic Wall Station shall mount to a standard single gang switch box.
4. Graphic Wall Station shall utilize standard Cat5 cabling for connection to system SmartPORT. Provide two RJ45 ports to allow daisy chain connection with other NX Smart Switches.
5. Graphic Wall Station shall operate seamlessly with other NX Smart Switches.
6. Graphic Wall Station shall provide a 4GB microSD card for storing user preferences that include the quantity of controls per screen, function names, screen navigation, home screen selection, and custom screen saver graphic image.
7. Graphic Wall Station screens can be configured to meet project requirements for control of up to 16 groups, each with provision for On/Off and dimming, up to 16 preset scenes, or CCT color control.
8. Graphic Wall Station shall be capable of local control within a single space or configured for master control across spaces or building wide.
9. Graphic Wall Station shall have an optional password access control that will require a secure PIN to access the station.
10. Graphic Wall Station shall have adjustable screensaver timeout and backlight brightness.
11. Graphic Wall Station shall be supplied with a white bezel. Optional color change kit shall allow for Ivory, Grey, Light Almond, or Black.

B. NX Smart Switches (Wired)

1. Basis of Design Product: NX Lighting Controls System, NXSW Series Smart Switches (Wired).
2. NX Smart Switches (Wired) shall be of the programmable type using standard Cat5 cabling for connection to system SmartPORT™.
3. NX Smart Switches (Wired) shall have one to six buttons and provide lighting control functions as called out and shown on the plans.
4. NX Smart Switches (Wired) shall be available with the following specialty versions:
 - a. OO: On/Off
 - b. ORLO: On/Raise/Lower/Off
 - c. RL: Raise/Lower
 - d. TO: Timed-On
 - e. SS: Scene
5. Construction:
 - a. Housing: Rugged, high impact, injection molded plastic
 - b. Mounting: Switches shall be capable of being mounted to single-gang and multi-gang wall boxes and shall be compatible with standard decorator style wall plates.
6. Electrical:
 - a. Class 2 Low Voltage 24VDC
 - b. Connection via two (2) RJ-45 SmartPORTs to allow for daisy chain connection of up to eight switches to each SmartPORT.
7. NX Smart Switches (Wired) shall be available in White, Ivory, Light Almond, Gray, Black, and Red.

C. NX Smart Switches (Wireless)

1. Basis of Design Product: NX Lighting Controls System, NXSW Series Smart Switches (Wireless).

2. NX Smart Switches (Wireless) shall be of the programmable type using the NX Lighting Controls App.
3. NX Smart Switches (Wireless) shall have a single rocker switch with two momentary switches and provide lighting control functions as called out and shown on the plans.
4. NX Smart Switches (Wireless) shall be programmable with the following switch functions:
 - a. On/Off
 - b. On/Raise
 - c. Off/Lower
 - d. Raise
 - e. Lower
 - f. Timed-On
 - g. Scene
5. Construction:
 - a. Housing: Rugged, high impact, injection molded plastic
 - b. Mounting: Switches shall be capable of being mounted directly to wall surfaces using provided 3M Command™ Strip, and to single-gang and multi-gang wall boxes and shall be compatible with standard decorator style wall plates (not included).
 - c. Switches shall include a built-in level to ensure device is mounted properly.
6. Electrical:
 - a. Class 2 Low Voltage 24VDC
 - b. 3VDC, 5.4mA
 - c. Powered using CR2032 battery only
7. NX Smart Switches (Wireless) shall be available in White.

D. NX Audio Visual Interface Module

1. Basis of Design Product: NX Lighting Controls System, NXAVM Series Audio Visual Interface Module.
2. NX Audio Visual Interface Module shall enable third-party systems to digitally interface with an NX Lighting Controls System.
3. NX Audio Visual Interface Module shall provide an ASCII based command set to interface with third-party systems such as Audio-Visual systems to send commands to and receive query status from an NX system.
4. NX Audio Visual Interface Module shall feature a DB9 connector and support RS232 serial communication, providing control and status for a single zone.
5. NX Audio Visual Interface Module shall mount to a standard 4 11/16" junction box.

2.9 SOFTWARE INTERFACES

A. NX Lighting Controls App

1. NX Lighting Controls App shall provide Bluetooth® wireless setup and configuration of NX system devices and luminaires equipped with an NX In-Fixture Module and smart sensor.
2. NX Lighting Controls App shall be available in Android and iOS versions for free download from Google Play™ or Apple® App Store.
3. NX Lighting Controls App shall connect to NX devices via NXBTR/NXBTC modules, NXSMP/NXSMP2 sensors and radio modules via Bluetooth BLE.
4. NX Lighting Controls App shall enable easy setup and configuration of NX room devices and NX panels.
5. NX Lighting Controls App shall enable users to create custom schedules and presets.

6. NX Lighting Controls App shall be able to configure SpectraSync™ or SpectraClean™ enabled luminaires.
7. NX Lighting Controls App shall globally discover wireless enabled luminaires and devices.
8. NX Lighting Controls App shall include the IntelliSCOPE™ visual diagnostic tool for real-time calibration and testing of NX digital smart sensors.

B. Digital Room Lighting Controller: Distributed intelligent lighting controller panel with the ability to function as stand-alone lighting control panel or as part of networked system. Automatically configures smart switch stations, occupancy sensors, and manual control switches for energy efficient room control solution. Configuration and power monitoring using Bluetooth-enabled apps and through area controller. Conforms with UL916 and Certified to CAN/CSA C22.2; IC Approved; Title 24 compliant. Factory assembled and tested.

1. Basis of Design Product: Hubbell Control Solutions, NXRC Series Room Controller.
2. [Single] [and] [dual] relay for on/off and bi-level control.
3. Receptacle control.
4. 0-10VDC full range dimming control interface.
5. Notification: Override push button and LED status/failure indicators for each relay.
6. Housing: GSM UL-rated 94 HB plastic.
7. Plenum rated.
8. Input: 120/277/347VAC, 50-60Hz.
9. Output:
 - a. 20A, Tungsten, 120VAC only.
 - b. 20A, Magnetic Ballast.
 - c. 16A, Electronic Ballast.
 - d. 1 H.P. Motor @120V, 3/4 H.P. @277V; 1/2 H.P.@347V
10. Output, Low Voltage Ports:
 - a. Class 2
 - b. 24VDC, 250mA MAX (all outputs combined)
 - c. RS485 digital communication
11. Dimming: Class 2 / Class 1.

2.10 CONDUCTORS AND CABLING

2.11 Power Supply Side of Remote-Control Power Sources: Comply with network manufacturer's requirements and requirements of Division 26 Section "Low-Voltage Electrical Power Conductors

2.12 PROTECTIVE CAGES

- A. Provide protective cages for all devices located in the Gymnasium and other areas shown on the Drawings.

2.13 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. Provide quantities as required.

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 271501 requirements.
 4. Document final wiring location, routing, and topology on as built drawings.
- C. Provide 0-10V wiring between digital lighting room controllers and 0-10V dimming drivers in luminaires.
- D. All line voltage connections shall be tagged to indicate circuit and switched legs.
- E. Test all devices to ensure proper communication.

- F. 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.
- G. 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.)
- H. 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.
- I. Tighten all panel Class I conductors from both circuit breaker and to loads to torque ratings as marked on enclosure UL label.
- J. 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.
- K. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.
- L. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.
- M. Wiring Methods:
 - 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. 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 POST STARTUP ADJUSTMENTS

- A. Provide a scheduled visit within the warranty period for commissioning assistance, system optimization, and troubleshooting.

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. 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 260940

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.
- 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.
- 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

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

SECTION 262413 – SWITCHBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Base Bid – Main Switchboard MDS will be Owner-furnished and Contractor installed. Contractor is responsible for housekeeping pad, rigging and unloading of switchboard sections and assembly on site.
- B. Alternate EC-4 – Contractor shall provide Switchboard MDS.

1.2 SECTION INCLUDES

- A. Main Switchboard
- B. Distribution Switchboard

1.3 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)
- W. Federal Specification W-S-865 – Enclosed Knife Switch

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 front and side elevations with overall dimensions, conduit entrance locations and requirements, nameplate legends, one-line diagrams, equipment schedule and switchboard instrument details.
 - d. Wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer installed wiring and field installed wiring, and between components provided by the manufacturer and those provided by others.
 - e. Utility Company approval letter for metering sections.

1.5 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual location of switchboards, indicate actual branch circuit arrangements.
- C. Operation Data: Include instructions for operating power monitoring and other accessories.
- D. Maintenance Data: Include spare parts data listing recommended maintenance procedures and intervals.
- E. Submit record copy of all testing performed.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing switchgear 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 a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.
- C. Provide UL Service Entrance Equipment label on all units used as service entrance equipment.

1.8 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.
- B. Each switchboard sections shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.
- C. Inspect and report concealed damage to carrier within their required time-period.
- D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic.
- E. For switchboards installed outdoor or temporary stored in an unheated space, provide temporary electric heaters to prevent condensation in each section.
- F. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.9 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

1.10 MAINTENANCE MATERIALS

- A. Provide an accessory tool set and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Provide two of each key.

1.11 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Square D Company
- 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 SWITCHBOARDS

- A. Utility Metering Compartment: Provide fabricated compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.
- B. Nominal System Voltage: Refer to the Switchboard Schedules.
- C. Main Bus: Refer to the Switchboard Schedules.
- D. Short Circuit Current Rating: Refer to the Switchboard Schedules. Provide 65,000 rms symmetrical amperes if not noted on the Switchboard Schedules.
- E. Enclosure: Provide steel enclosure, in compliance with UL 891.
 - 1. Type 1 – Indoor:
 - a. Sections shall be aligned front and rear.
 - b. Switchboard height shall be 91.5" including 1.5" floor sills and excluding lifting members and pull boxes.
 - c. The switchboard shall be of a deadfront construction.
 - d. The switchboard shall have front access only.
 - e. The switchboard frame shall be of formed steel rigidly bolted together to support all cover plates, bussing and component devices during shipment and installation.
 - f. Steel base channels shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting.
 - g. Each switchboard section shall have an open bottom and an individually removable top plate for installation and termination of conduit.

- h. The switchboard enclosure shall be painted on all exterior surfaces. The paint shall be a medium gray, ANSI #49, applied by the electro-deposition process over an iron phosphate pre-treatment.
 - i. All front covers shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.
 - j. Top and bottom conduit areas shall be clearly indicated on shop drawings.
2. Type 3R – Exterior:
- a. Sections shall be aligned front and rear.
 - b. Switchboard height shall be 91.5" including 1.5" floor sills and excluding lifting members and pull boxes.
 - c. The switchboard shall be of a deadfront construction.
 - d. The switchboard shall have front access only.
 - e. The switchboard frame shall be of formed steel rigidly bolted together to support all cover plates, bussing and component devices during shipment and installation.
 - f. Steel base channels shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting.
 - g. Each switchboard section shall have an open bottom and an individually removable top plate for installation and termination of conduit.
 - h. The switchboard enclosure shall be painted on all exterior surfaces. The paint shall be a medium gray, ANSI #49, applied by the electro-deposition process over an iron phosphate pre-treatment.
 - i. All front covers shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.
 - j. Top and bottom conduit areas shall be clearly indicated on shop drawings.
 - k. Strip Heaters: Provide factory installed electric strip heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
 - 1) Strip Heater Control: Provide thermostats to maintain temperature of each section above expected dew point. Provide humidistat to control humidity of each section.
 - 2) Strip Heater Power Source: Provide transformer with primary and secondary fuse protection factory installed in switchboard.
- F. Barriers: Provide barriers between adjacent switchboard sections.
- G. Auxiliary Sections: Auxiliary sections shall be matched and aligned with switchboard.
- H. Bus Transition and Incoming Pull Sections: Match and align with switchboard.
- I. 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.
- J. 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.
- K. Future Provisions: All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
- L. Accessibility: Accessible from the front only of the switchboard.
- M. Provide manufacture start-up and training when required for the equipment provided.

2.3 INCOMING MAIN SECTION DEVICES FOR SWITCHBOARDS

- A. Provide main type as indicated on the Switchboard Schedule or Power Riser Diagram.
- B. Main Circuit Breaker:
 - 1. Electronic trip molded case standard function 80% rated circuit breakers through 5000A. Provide 100% when indicated on the Switchboard Schedules.
 - a. 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.
 - 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.
 - d. 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.
 - e. 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.

- f. Lugs shall be UL Listed to accept solid or stranded conductors.
- g. Breaker Accessories: Provide when indicated on the Switchboard Schedules.
 - 1) Mechanical Lug Kits
 - 2) Zone Selective Interlocking

2.4 ARC ENERGY REDUCTION SWITCH (AERS)

- A. Provide for 1200A and above switchboards.
- B. An ARC Energy Reduction switch shall be made available mounted internally to the panelboard for breakers required per the National Electrical 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, breaker status, breaker metering and maintenance data. Device shall be capable of sending breaker alarms via email and smart phone application.

2.5 DISTRIBUTION SECTION DEVICES FOR SWITCHBOARDS

- A. General:
 - 1. Circuit breakers shall be 80% rated unless otherwise indicated on the Switchboard Schedules.
 - 2. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the associated Switchboard Schedules.
 - 3. Circuit breaker(s) shall be a group mounted plug-on with mechanical restraint on a common pan or rail assembly.
 - 4. 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.
 - 5. 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.
 - 6. Line-side circuit breaker connections are to be jaw type.
 - 7. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
 - 8. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with a common trip handle for 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.
 - 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 Switchboard 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

B. Breaker Types:

- 1. Thermal Magnetic Circuit Breaker (TM)
 - a. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
- 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 the Drawings.

2.6 FUSES

A. Refer to Specification Section 262813 – Fuses.

- B. Interrupting Rating: 200,000 rms amperes.

2.7 CUSTOMER METERING

- A. Power Monitoring: Provide one power and energy meter in each switchboard and any additional shown on the 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 switchboard 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 switchboard lineup.
 - 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 Switchboards.
 - 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 MULTI-CIRCUIT POWER METER

- A. Provide multi-circuit power meter when indicated on the Panel Schedules or Power Riser Diagram.

1. Manufacturers:
 - a. Square D Company Model HDPM6000 Series
 - b. Eaton
 2. General Provisions: The meter shall be a microprocessor-based branch monitoring system supporting direct reading metered or calculated values for up to one hundred ninety-two (192) branch circuits or a combination of panelboards and sub-feed breakers.
 3. Measured Values:
 - a. The meter shall be able to support 1, 2, and 3 pole breakers
 - b. All the meter measured values shall be available through the HDPM Modbus interface
 - c. The meter shall provide at a minimum the following current values:
 - 1) Current per branch channel
 - 2) Current total per circuit
 - d. The meter shall provide at a minimum the following power values:
 - 1) Real power (per channel, circuit total)
 - 2) Reactive power (per channel, circuit total)
 - 3) Apparent power (per channel, circuit total)
 - 4) Power factor – true (per channel, circuit total)
 - 5) Maximum real power (per channel, circuit total)
 - e. The meter shall provide at a minimum the following energy values:
 - 1) Accumulated real kWh energy (per channel, circuit total)
- B. Provide enclosure with step down transformer powered by panelboard.
- C. Provide Manufacturers Field Service to start-up, set-up, and train the Owner for all meters.

2.9 METERING SOFTWARE

- A. Power Monitoring: Provide Power Monitoring Software to monitor all customer meters included in the project.
1. Basis of Design Manufacturer:
 - a. Square D Company with the following components:
 - 1) Power Monitoring Expert Standard Edition BASE license (1 Engineering Client & 1 Web Client) – Model PSWSANCZZSPEZZ
 - 2) Device Packs Required for Power Monitoring Expert software – Model PSWDXNCZZNPEZZ
 - 3) One custom graphic screen showing all equipment – Model 9784VISTAMM
 2. Alternate manufacturers as listed below:
 - a. Eaton Model FORESEER Series
 - b. Siemens Model WinPM.net Series
- B. Power Monitoring Software shall be licensed to communicate to all customer meters and intelligent devices included in the project to a common software platform.
- C. Manufacturer of software shall provide onsite start-up, set-up, and training on the use of the software.

2.10 INTEGRATED SURGE SUPPRESSION DEVICE

- A. Provide integrated surge suppression device when indicated on the Switchboard 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:
 - 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: Switchboard
 - 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 TVS4IMA24
 - b. Eaton Model SPD250480Y2C
 - c. Siemens Model TPS3E0625X02, TPS3E0525X2
- D. Internal Type L1 Unit: Non-Critical Load Applications:

1. Voltage Rating: 208Y/120V, 3-phase, 4-wire
2. Application: Switchboard
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
7. The following models are acceptable:
 - a. Square D Company Model TVS2IMA24
 - b. Eaton Model SPD250208Y2C
 - c. Siemens Model TPS3C0625X02, TPS3C0525X2

2.11 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. Engraved legend shall be black letters on white face.
 2. Punched or drilled for mechanical fasteners.
- B. Mimic Bus: The nameplate shall be at least .0625" thick and located at eye level on the front cover of the switchboard incoming service section.
 1. Continuously integrated mimic bus factory applied to front of switchboard.
 2. Arrange in single line diagram format using symbols and letter designations consistent with final mimic bus diagram.
 3. Coordinate mimic bus segments with devices in switchboard sections to which applied.
 4. Produce a concise visual presentation of principal switchboard components and connections.
- C. 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 switchboard 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 switchboard.

3.3 INSTALLATION

- A. Install switchboard in accordance with NEMA PB 2.1, NEC Standards, Local Codes, and manufacturer's instructions.
- B. Torque all bolted connections and mechanical fasteners after placing switchboard per manufacturer's specifications.
- C. Install fuses in each switch and coordinate sizes with connected load.
- D. Provide seismic restraints when Section 260125 is included in the specification.
- E. Provide breaker closures for unused spaces in switchboards.
- F. Provide engraved plastic nameplates for each switchboard with 3/8" high lettering. Label shall include the following:
 - 1. Switchboard Name
 - 2. Voltage, Phase, Wire
 - 3. Location of source of incoming power which feeds switchboard.
- G. Provide engraved plastic nameplates for each feeder overcurrent device showing name of load, each spare size and each available space size with 1/2" high lettering.
- H. Provide mimic bus to indicate all switchboard components.
- I. Provide accessories which prevent circuit breaker handles from being manually moved from the ON position for the handles of all circuit breaker which transformers.
- J. Ground and bond panelboard enclosure in accordance with Section 260526.
- K. Provide category 6 cable in 3/4" conduit from each meter to nearest MDF/IDF and terminate on both ends unless otherwise noted.
- L. 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.
- M. Where replacing existing switchboards 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.
- N. Contractor shall trace all circuits listed as "Existing Circuits" and provide the correct description for the circuit. Existing Circuit will not be acceptable on the Final Switchboard labels.
- O. Contractor is responsible for any equipment that needs to be disassembled and reassembled to get into the location specified on the drawings.
- P. 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. Measure, using a Megger, the insulation resistance of each bus section phase-to-phase and phase-to-ground for 1 minute each, at minimum test voltage of 1000 VDC; minimum acceptable value for insulation resistance is 1 megohms. Refer to manufacturer's literature for specific testing procedures.
- D. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.
- E. Test ground fault systems per NEC Article 230.
- F. Apply ANSI 61 (or other appropriate color paint) as needed.

3.5 SWITCHBOARD SCHEDULES

- A. As indicated in the Specifications or Drawings.

3.6 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. Adjust circuit breaker trip and time delay settings to values indicated in the Coordination Study.

3.7 FLOOR LINE MARKING

- A. Provide a 2" yellow floor line marking showing clear working distance on the floor in front of the switchboard with wordage within space which shall be: "Do Not Block This Piece of Electrical Equipment". Working clearance shall be as noted in the NEC.

3.8 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.

3.9 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 262413

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.
 - 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
- 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 "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.

- I. All Panelboards with greater than 42 poles shall have 2 panel backboxes. Single backboxes with more than 42 poles will be unacceptable.
- J. 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.

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.
 - 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 braker 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.
- 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.
 - 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)
 - 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, 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 MULTI-CIRCUIT POWER METER

- A. Provide multi-circuit power meter when indicated on the Panel Schedules or Power Riser Diagram.
 - 1. Manufacturers:
 - a. Square D Company Model HDPM6000 Series
 - b. Eaton
 - 2. General Provisions: The meter shall be a microprocessor-based branch monitoring system supporting direct reading metered or calculated values for up to one hundred ninety-two (192) branch circuits or a combination of panelboards and sub-feed breakers.
 - 3. Measured Values:
 - a. The meter shall be able to support 1, 2, and 3 pole breakers
 - b. All the meter measured values shall be available through the HDPM Modbus interface
 - c. The meter shall provide at a minimum the following current values:
 - 1) Current per branch channel
 - 2) Current total per circuit
 - d. The meter shall provide at a minimum the following power values:

- 1) Real power (per channel, circuit total)
- 2) Reactive power (per channel, circuit total)
- 3) Apparent power (per channel, circuit total)
- 4) Power factor – true (per channel, circuit total)
- 5) Maximum real power (per channel, circuit total)
- e. The meter shall provide at a minimum the following energy values:
 - 1) Accumulated real kWh energy (per channel, circuit total)
- B. Provide enclosure with step down transformer powered by panelboard.
- C. Provide Manufacturers Field Service to start-up, set-up, and train the Owner for all meters.

2.9 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:
 - 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 TVS4IMA24
 - 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 TVS4IMA16
 - 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 TVS4IMA12
 - 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
 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

2.10 INTEGRATED CONTACTOR FOR PANELBOARDS

A. Provide integrated contactor when indicated on the Panel Schedules or Power Riser Diagram.

B. Contactor Main:

1. The contactor main shall be a Schneider Electric 8903 Type S for contactor ratings up to 200A. This remote-controlled switch shall be a single coil, electrically operated, mechanically held contactor. The main contactor shall be UL 67 listed for use in panelboards and rated 22,000 amps rms symmetrical when used with a molded case breaker and 10,000 amps symmetrical when used with a current limiting fuse.
2. If the contactor is rated above 200A, the contactor shall be remote mounted in an enclosure to match the panelboard.

2.11 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.
- F. Provide breaker closures for unused spaces in panelboards.
- G. Provide panel skirts when surface mounted panelboards are installed in other than dedicated electrical and/or mechanical rooms.
- H. 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.
- I. 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.
- J. 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.
- K. 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.
- L. Ground and bond panelboard enclosure in accordance with Section 260526.
- M. Provide Category 6A cable in 1" conduit from each meter to nearest MDF/IDF and terminate on both ends unless otherwise noted.

- N. 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.
- O. 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.
- P. 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.
- Q. 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.
- 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

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

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.

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.
- C. 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.
- D. Digital Time Switch: 120/277V, 20A:
1. Watt Stopper Model TS-400
 2. Sensor Switch Model PTS-60
- E. Color: Ivory unless directed otherwise by Architect.

2.2 WALL DIMMERS

- A. Single Pole, LED 0-10V, 120V-277V with slider and On-Off Switch:
1. Lutron Model DVSTV-XX
 2. Provide 3-way switches of the same series as required.
- B. Provide dimmers compatible with LED Drivers.
- C. Color: Ivory unless directed otherwise by Architect.

2.3 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 Half-Controlled Duplex Receptable for Plug Load Control: 125V, 20A:
1. Hubbell Model HBL5362C1XXTR
 2. Pass & Seymour Model TR5362CHX
- C. 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.
 6. All GFI Receptacles shall be weather resistant.
- D. Tamper-Resistant Duplex Convenience Receptacle with USB Charger: 125V, 20A:
1. Hubbell Model USB20AC5PDX or USB20CPDX
 2. Pass & Seymour Model TR20USBAC6X or TR20USBCC6X
 3. Engineer's Choice on USB Type.
- E. 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.
- F. 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.
- G. Tamper-Resistant USB Charger/5V DC Output: 125V, 20A:
1. Hubbell Model AVPS202X
- H. Color: Ivory unless directed otherwise by Architect.

2.4 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. Range Receptacle (NEMA 14-50R):
1. Hubbell Model RR450F
 2. Leviton Model 279
 3. Pass & Seymour Model 3894
 4. Range 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. 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.)
- D. Color: Ivory unless directed otherwise by Architect.

2.5 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.
 - 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.

2.6 WALL PLATES

- A. Polycarbonate/Nylon Receptacle Cover Plate for All Areas Except As Noted Below: Interior Finish Walls - Ivory or as directed by Architect:
 - 1. Hubbell Model NP8I/NP26I or P8I/P26I
 - 2. Leviton Model 80703-I/80401-NI
 - 3. Pass & Seymour Model TP8I/SP26I
 - 4. When plastic wall plates are used throughout on a commercial project, provide super stainless-steel wall plates in exposed commercial kitchen areas.
- B. Super Stainless-Steel Receptacle Cover Plate for Kitchen and Dishwashing Areas: Interior Finish Walls:
 - 1. Hubbell Model SS8/SS26
 - 2. Leviton Model 84003/84401-40
 - 3. Pass & Seymour Model SS8/SS26
- C. Polycarbonate/Nylon Switch Cover Plate for All Areas Except As Noted Below: Interior Finish Walls - Ivory or as directed by Architect:
 - 1. Hubbell Model NP1 or P1
 - 2. Leviton Model 80701-I
 - 3. Pass & Seymour Model SP1I

4. When plastic wall plates are used throughout on a commercial project, provide super stainless-steel type wall plates in exposed commercial kitchen areas.
- D. Super Stainless-Steel Switch Cover Plate for Kitchen and Dishwashing Areas: Interior Finish Walls:
 1. Hubbell Model SS1
 2. Leviton Model 84001
 3. Pass & Seymour Model SS1
- E. 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
- F. Metal Switch Cover Plate for Electrical Rooms, Mechanical Rooms, and Boiler Rooms:
 1. Cooper Crouse-Hinds Model TP512
 2. Appleton Model 8361
 3. Steel City Model RS-9
- G. Weatherproof While In Use Cover for 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.
- H. 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.
- I. Provide all devices, outlet boxes, junction boxes, etc with the appropriate type cover plate.
- J. Provide junior or jumbo size plates as required of the same series and type for all outlets installed in masonry walls.
- K. 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.

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.
- 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.
- 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.

END OF SECTION 262726

SECTION 262730 – FLOOR BOXES & POKE-THRU’S

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Kitchen Pedestals
- B. Multi-Service Floor Boxes
- C. Multi-Service Poke-Thru’s

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.

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 or poke thru's where specific model numbers are listed on the Drawings.
- B. Contractor to provide floor box or poke-thru's 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 or poke-thru's must meet or exceed devices listed in other 260000 sections.

2.2 KITCHEN PEDESTALS

- A. Two or Four Gang Large Capacity Pedestals:
 - 1. Housing: Brushed Aluminum
 - 2. Hub: 3/4" or 1" as required for application
 - 3. Plate: Stainless Steel
 - 4. Configuration: As indicated or required
 - 5. Manufacturers: Hubbell Model SA6685G or SA6688G
- B. Pedestal Floor Box:
 - 1. Housing: Cast Iron
 - 2. Plate: Round Aluminum (Verify with Architect)
 - 3. Deep or shallow as required
 - 4. Configuration: As indicated or required
 - 5. Manufacturers:

- a. Hubbell Model FB2536/FB2546
- 6. Depth as required

2.3 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 or RFBA6C30OG (epoxy coated); RFBA10C55 or RFBA6C30 (stamped steel) with (1) XCTC2NK cover, duplex mounting plates, data mounting plates and all required components for a complete installation.
 - b. Hubbell Model CFB10G55RCRE or CFB6G30RCRE (epoxy coated); CFB10G55RE or CFB6G30RE (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 or other finish selected by Architect during shop drawing review. All standard finishes shall be available and included in Base Bid.
 - 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.

2.4 MULTI-SERVICE POKE THRU'S

- A. Recessed Poke-Thru Convenience Receptacle(s) and Telecommunication Outlet(s).
 - 1. Housing: Stamped Steel
 - 2. Plate Finish: Nickel or other finish selected by Architect during shop drawing review. All standard finishes shall be available and included in Base Bid.
 - 3. Configuration: Receptacles and Telecommunication outlets as indicated on the Drawings.

4. Size: 10", 8" or 6" cored holes and matched to floor thickness. Provide diameter as required to support devices identified to be installed in poke-thru on the drawings or drawing details.
 5. Fire Rating: 2-hour rated
 6. Cover shall meet UL 514A Water Exclusion Test.
 7. Wiring Raceways and Compartments: 1-3/4" conduit channel and 2-1/2" conduit channels for power and telecommunication cabling.
 8. Manufacturers:
 - a. Wiremold Model 10AT, 8AT or 6AT with (1) XCTC2NK cover, duplex mounting plates, data mounting plates and all required components for a complete installation.
 - b. Hubbell Model S1R10PTFIT, S1R8PTFIT or S1R6PTFIT with (1) S1RXCVRNKL 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.
- B. Multi-Service Furniture Feed Poke-Thru:
1. Housing: Stamped Steel
 2. Plate Finish: Aluminum or other finished selected by Architect during shop drawing reviews. All standard finishes shall be available and included in Base Bid.
 3. Telecommunication Configuration – 1 – 3/4" liquid tight conduit from floor box to surface mount box in wireway of furniture.
 4. Power Configuration: 1 – 1-1/4" liquid tight conduit from poke-thru to surface mount box in wireway of furniture or connection at poke-thru from whip from furniture.
 5. Fire Rating: 2-hour rated
 6. Cover shall meet UL b514A Water Exclusion Test
 7. Wiring Raceways and Compartments: 1 – 1-1/4" conduit channel for wiring
 8. Manufacturers:
 - a. Wiremold Model 4FFATCAL
 - b. Hubbell Model S1R4PTAVFITwith S1R4FFCVRNKL
 - c. Provide all necessary power and telecommunication fittings required for a complete installation.

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 floor boxes or poke-thru's with furniture provided by General Contractor or Owner before roughing-in.
- D. Install all wiring between floor box or poke-thru 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 and poke-thru's to suit the arrangement of furniture and as recommended by Architect.

3.6 CLEANING

- A. Clean installed work as required.

END OF SECTION 262730

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.

1.8 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Cooper Bussman
- B. Littelfuse, 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. Fuses rated up to 600 amperes shall be current limiting, time delay, 600-volt, UL Class RK5.
- E. Fuses rated 601 up to 5,000 amperes shall be current limiting, time delay, 600-volt, UL Class L.
- F. Motor Load Feeder Switches: Current Limiting Class RK1 (time delay).
- G. Motor Branch Circuits: Class RK5. (time delay).
- H. 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.

END OF SECTION 262813

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.

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.

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.

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

SECTION 262900 – ELECTRIC CONTROLS, PUSHBUTTONS, RELAYS, AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Components for the following systems:
 - 1. Gas Valve Controls
 - 2. Power Controls

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NEMA ICS 1 - General Standards for Industrial Control Systems
- C. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies
- D. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- E. NEMA ST 1 - Standard for Specialty Transformers (Except General Purpose Type.)

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 and connection requirements with the specific item and model numbers highlighted.
 - d. Manufacturers' installation instructions.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Operation Data: Include instructions for operating equipment.
- C. Maintenance Data: Include spare parts data, recommended maintenance procedures and intervals.

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 Underwriters laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.7 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 CONTROL SWITCHES AND STATIONS

- A. Operators and Contact Blocks - Unless noted otherwise, operators for pilot duty control devices shall be heavy duty, oil tight NEMA 13, and shall be furnished with the quantity and types of contact blocks shown. All operators shall be 30.5 mm in diameter and suitable for cover mounting in a 1-7/32" diameter notch type cover hole and shall be held in place by the function nameplate or locking thrust washer in the event no nameplate is used. Pushbuttons and selector-switches shall have interchangeable inserts or caps in eight different colors for function color coding. Pushbutton inserts or caps and selector switch knobs shall be removable from the front of the control station without disturbing the wiring or mounting of the control units. Selector switches shall have removable knobs in eight different colors for function color coding. Contact blocks shall be single-pole, single-throw (SPST) or single-pole, double-throw (SPDT) and shall be suitable for mounting side by side and/or in tandem to the base of the operator. Terminals shall be pressure wire type with a self-lifting pressure clamp that will compensate for wire of different size ranging from #12 - #18 solid or stranded. Contacts shall be double break. Contact tips shall be silver. Standard contacts shall be nominally rated 10 amps continuous duty, inductive and shall be capable of making 60 amps and breaking 6 amps at 0-120 volts and making 7200 VA and breaking 720 VA at 120-600 volts. Special contacts including logic reed and overlapping contacts shall be available for mounting on the operator in combination with standard blocks.

- 1. Provide NEMA 4 devices for exterior locations.

- B. Pilot Lights - Unless noted otherwise, pilot lights shall be heavy duty NEMA 13, transformer type with a round plastic lens. Pilot lights shall be standard full-sized units which mount in a 1-7/16" diameter hole. Terminals shall have a wire clamp plate suitable for holding two stranded wires, 18 AWG to 12 AWG.
 - 1. Provide NEMA 4 devices for exterior locations.

2.3 PUSH BUTTON OPERATORS: NEMA ICS 2

- A. Heavy duty type with red mushroom button, NEMA 1-B with stainless steel flush plate.

2.4 PUSH BUTTON OPERATORS WITH KEY RESET: NEMA ICS 2

- A. Heavy duty type with key reset switch, illuminated red mushroom button and stainless-steel flush plate.

2.5 SELECTOR SWITCH OPERATORS: NEMA ICS 2

- A. Two, three or four position rotary selector switches with contact blocks required.

2.6 START STOP PUSHBUTTON AND 120 VOLT AC or DC PILOT LIGHT STATIONS

- A. Heavy duty, momentary contact type with general purpose enclosure.

2.7 HAND OFF-AUTO SELECTOR SWITCH STATIONS

- A. Heavy-duty, maintained contact type with general purpose enclosure.

2.8 CONTROL POWER TRANSFORMERS

- A. Transformer: NEMA ST 1; machine tool transformer with isolated secondary winding.
- B. Power Rating: As indicated or required.
- C. Voltage Rating: As indicated or required.

2.9 TERMINAL BLOCKS

- A. Manufacturers:
 - 1. Square D Company
 - 2. Eaton
 - 3. Siemens
- B. Terminal Blocks: ANSI/NEMA ICS 4
- C. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

- D. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 600 volts. Furnish blocks with a density of 3.4 blocks per inch or less.
- E. Provide ground bus terminal block, bonded to enclosure. Ground terminal blocks shall be plated bus bars pre-drilled to accept #16 through #6 conductors and provided with set screws or other manufactured assemblies meeting the requirements for panelboard ground bus assemblies.

2.10 CONDUCTORS

- A. Unless otherwise specified all power and control wiring shall be rated 600 volts, 98% conductivity copper, class B stranded, type THWN/MTW/AWM or MTW/AWM insulation.
- B. The following color code shall be observed for all single conductor control and power wiring used in the construction of control panels or for field wiring between panels and remote devices.
 - 1. Red - all control wires originating from the fused side of the control transformer
 - 2. White - all control wires connecting the common or neutral side of pilot lights, coils, horns, electronic controllers, etc. to the grounded side of the control transformer.
 - 3. Green - all ground wires.
 - 4. Yellow - all AC control wiring operating at a voltage higher than the secondary voltage of the control transformer.
 - 5. Blue - all DC power and control wiring.
 - 6. Black - All AC power wiring.
- C. Minimum conductor sizes shall be as follows:
 - 1. Control wiring unless otherwise noted - 14 AWG.
 - 2. Power wiring unless otherwise noted - 12 AWG.

2.11 TERMINALS AND CONNECTIONS

- A. All incoming and outgoing control and power wiring shall be terminated on numbered terminal blocks.
- B. Terminal blocks shall be UL listed, rated 600V, have an ampacity not less than that of the fuses protecting the circuit connected to them but in no case less than 30A, have box lug with set screw construction, and be Square D 9080 GR6B or equal. Terminal blocks with a density greater than 3.4 terminals per linear inch will not be accepted.
- C. Terminal blocks shall be installed in the locations shown.
- D. Spare terminal blocks shall be furnished. Spare terminals shall equal 20% of the active terminals but not fewer than two or as otherwise indicated. When terminals are segregated in required groups in a panel, spare terminals shall be distributed among the groups.
- E. Provide multiple terminals and flat metal jumper straps when multiple wires have the same number. No more than 2 wires and 2 jumpers shall be permitted under 1 terminal block screw.

- F. Furnish ring type solderless connectors at all terminals on control components which do not have box lugs or clamp plates specifically designed for stranded wire.

2.12 ENCLOSURES

- A. Interior Dry Locations: Type 1
- B. Interior Wet Locations: Type 4
- C. Exterior Locations: Type 3R
- D. Kitchen: Stainless Steel
- E. Dishwashing Rooms/Areas: Stainless Steel

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and equipment in accordance with manufacturer's instructions.
- B. Install relays in enclosures.
- C. Make electrical wiring interconnections as indicated.

END OF SECTION 262900

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.

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.
- 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.

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

SECTION 263100 – PHOTOVOLTAIC SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide all labor, materials, and equipment necessary to complete design and installation of a roof mounted photovoltaic system including equipment and connection to the main normal power switchboard as required for a nominal 129.6 KW (272 modules rated 600 W each) roof mounted photovoltaic arrays spread over three separate roof surfaces and nominal 132 KW inverter system consisting of exterior modular inverters with maximum power point tracking (MPPT) inverter input circuits, photovoltaic modules, each mounted on a roof mount rail system, quick-connect electrical connectors, DC wiring, rapid shutdown disconnects, DC and AC disconnects in compliance with NEC 2017.
- B. The system's photovoltaic array shall provide a peak (DC) power at Standard Test Conditions as detailed in final project specifications.

1.2 SUBMITTALS

- 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. Roof plans, section, and elevation details. Include support locations, penetration locations, conduit routing and conduit supports.
 - d. Shading analysis.
 - e. Estimated calculations of photovoltaic system production in kWh/year.
 - f. Location and type of all penetrations and roof structures.
 - g. Wiring and Interconnection drawings and three-wire
 - h. Electrical interconnect information.
 - i. Equipment cut sheets on the following:
 - 1) Photovoltaic Panels
 - 2) DC Disconnect Switch
 - 3) Inverter
 - 4) AC Disconnect Switch
 - 5) Rapid Shutdown Devices
 - 6) Metering and Monitoring Equipment
 - 7) Mounting System
 - 8) DC Cabling, including plug-in connectors
 - 9) Field and Factory Wiring Diagrams

1.3 SUBMITTALS FOR CLOSEOUT

- A. Submit under the provisions of Section 260010.
- B. Operation and Maintenance Data: For all photovoltaic system components and accessories, operation, and maintenance manuals.
- C. Provide two complete sets of the following data. Data shall be on 8-1/2" x 11" sheet or manufacturer's standard catalog, suitable for side binding. Include full product documentation from manufacturer, installer, and/or supplier including, but not limited to, the following items.
 - 1. Inverter, including optional equipment furnished:
 - a. Owners' manual with programming and installation instructions
 - b. Emergency operating procedures
 - c. Default program values and setpoints
 - d. Listing of field programmed variables and setpoints
 - e. Equipment wiring diagrams
 - f. Product model number, with name, address, and telephone number of the local representative
 - g. Starting, operating and shutdown procedures, including normal, seasonal, and emergency shutdown procedures
 - h. Schedule of maintenance work if any
 - i. Replacement parts list, including internal fuses
 - j. Warranty paperwork
 - 2. Photovoltaic Modules and balance of system components:
 - a. Owners' manual or manufacturer's product data sheet, as applicable
 - b. Equipment wiring diagrams
 - c. Product model number, with name, address, and telephone number of the local representative
 - d. Starting, operating and shutdown procedures, including normal, emergency, and seasonal shutdown procedures
 - e. Schedule of maintenance work if any
 - f. Replacement parts list, including fuses, diodes, etc.
 - g. Warranty paperwork
 - h. Cleaning agents and methods

1.4 QUALITY ASSURANCE

- A. Installation and equipment shall comply with all applicable codes, including but not limited to, Articles 690, 480 and 250 of the NEC. All products that are listed, tested, identified, or labeled by UL, FM, ETL, or other National Testing Organization shall be used when available. Non-listed products are only permitted when there is no listing.
- B. The system shall be supplied and installed by one manufacturer (or certified representative) with an established reputation and at least 5-years' experience in the manufacturing and installation of Photovoltaic Energy Systems of 20 KVA nominal or larger, and who shall be able to provide three references of similar installations rendering satisfactory service.

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 Underwriters Laboratories, Inc., or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.7 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 PHOTOVOLTAIC MODULES/COLLECTORS

- A. Manufacturers:
 - 1. Q-Cells
 - 2. Alternate Manufacturers:
 - a. First Solar
 - b. Mission Solar
- B. Basis of Design: Q-Cells Q.PEAK DUO XL-G11S
- C. Photovoltaic Collectors:
 - 1. Refer to Drawings for photovoltaic Basis of Design.
 - 2. Provide mounting and grounding clips as required.
 - 3. Minimum Performance Parameters as per IBC 1509.7.4, IRC M2302.3, UL 1703.
 - 4. Photovoltaic Panel Types:
 - a. Monocrystalline: Listed to UL 1703.
 - 5. Module and System Identification
 - a. Module or Panel:
 - 1) Listed to UL 969 for weather resistance.
 - 2) Listed to UL 1703 for marking contents and format.
 - 3) Identification Content and Format: per NEC.
 - 4) Identification for DC Conduit, Raceways, Enclosures, Cable Assemblies, and Junction Boxes: IFC 605.
 - 5) Identification for Inverter: per NEC.
 - b. Bypass diodes shall be built into each PV module either between each cell or each string of cells.
 - c. Hail Protection: Compliant with testing procedure per ASTM E-1038.
 - d. Lightning Protection: Shall ground according to manufacturer instructions per UL 1703.

2.2 INVERTERS

- A. Manufacturers:
 - 1. Yaskawa Solectria Solar
 - 2. Alternate Manufacturers:
 - a. Huawei
 - b. SMA America
- B. Basis of Design: Yaskawa Solectria Solar Models PVI-60TL and PVI-36TL-480V-V2
- C. Refer to Drawings for inverter sizes and quantities.
- D. Inverters shall be compact, 3- phase, transformerless, commercial string inverters.
- E. Inverter shall multiple independent Maximum Power Point Tracking (MPPT) inputs.
- F. Inverter shall be housed in a NEMA 4X enclosure and suitable for indoor and outdoor installation.
- G. Inverters shall include AC and DC disconnects.
- H. Inverter shall include embedded DC/AC switches and multiple fused string inputs and not require an external combiner box.
- I. Inverters shall have user-interactive LCD display.
- J. Inverters shall have integrated fused string combiners.
- K. Inverter shall use thin-film capacitors to extend inverter's service life.
- L. Multiple inverters shall be capable of wired in a parallel configuration.
- M. Inverters shall include a built-in PV Rapid Shutdown module-level Sunspec compliant or similar wireless transmitter. If wireless transmitter is not integral to the inverter an exterior wireless transmitter in a suitable enclosure shall be provided.
- N. Inverters shall have the following features:
 - 1. 1000 VDC
 - 2. Efficiency - 98.4% (CEC efficiency – 98.0%)
 - 3. Enhanced DSP control
 - 4. Comprehensive protection functions
 - 5. Advanced thermal design
 - 6. Web-based monitoring
 - 7. Modbus communication
 - 8. Shade Cover
 - 9. DC/AC disconnect covers
- O. Inverter Protection Functions:
 - 1. Reverse polarity protection of DC inputs

2. Short-circuit protection
3. Arc-Fault Circuit Interruption
4. Anti-islanding protection
5. Input and output over-voltage protection
6. Input over-current protection
7. Monitoring of DC input insulation against ground
8. Monitoring of AC output voltage and frequency
9. Monitoring of leakage current against ground
10. Monitoring of DC injection from AC output
11. Monitoring of ambient temperature
12. Monitoring of IGBT module temperature

P. Input Voltage:

1. Maximum DC Voltage - 1000VDC
2. Operating DC Voltage - 200-950VDC

Q. Output Voltage: 480 VAC, 3-Phase, 4-Wire

R. Manufacturer's Warranty: 10-years with options for 15 and 20 years.

S. Provide conduit/cabling as required for the system.

2.3 MODULE-LEVEL RAPID SHUTDOWN

A. Manufacturers:

1. APsmart
2. Alternate Manufacturers:
 - a. Alternate manufacturers subject to compliance with the following requirements:
 - b. The performance and operating characteristics meet or exceed the Basis of Design.
 - c. The alternate manufacturer shall include all features, accessories and additional equipment required for a complete installation.

B. Basis of Design: APsmart Models RSD-S-PLC and RSD-D-PLC

C. Module-level rapid shut down control meeting SunSpec requirements and the NEC.

D. The rapid-shutdown module shall maintain normal function by continually receiving a heartbeat signal from a SunSpec compliant transmitter. The module shall execute a rapid system shutdown when the transmitter signal is absent.

E. Electrical Ratings

1. Input
 - a. Operating Voltage Range: 8-80 volts
 - b. Maximum Continuous Current (Imax): 15 amperes
 - c. Maximum Short Circuit Current (I_{sc}): 25 amperes
2. Output
 - a. Operating Voltage Range: 8-80 volts
 - b. Maximum System Voltage: 1000/1500 volts

- c. Maximum Series Fuse Rating: 30 amperes
- 3. Mechanical
 - a. Operating Ambient Temperature Range: -40°F to +185°F (-40°C to +85°C)
 - b. Dimensions: 5.5" x 1.3" x 0.7"
- 4. Cable Lengths
 - a. Input: 9.8" (250mm)
 - b. Output: 47.2" (1200mm)
- 5. Cable Cross Section Size: 12 AWG
- 6. Connectors: MC4
- 7. Enclosure: NEMA Type 6P, IP68

2.4 INSTRUMENTATION

- A. Meters: If applicable and system is grid-connected, use net smart meter provided by the serving electric utility.
- B. Sensors:
 - 1. Temperature sensor shall be a component in the MPPT control system.
 - 2. Provide data acquisition sensors to measure irradiance, wind speed, and ambient and PV module temperatures. Any additional sensors shall require a conduit separate from the current conductor conduit.
- C. Data logger/Monitoring System: Provide a packaged system capable of string-level monitoring or in the case of micro-inverters, capable of monitoring and logging an individual module's information.

2.5 PHOTOVOLTAIC MODULE ROOF MOUNTING

- A. Manufacturers
 - 1. UNIRAC
 - 2. Alternate Manufacturers
 - a. Alternate manufacturers subject to compliance with the following requirements:
 - b. The performance and operating characteristics meet or exceed the Basis of Design.
 - c. The alternate manufacturer shall include all features, accessories and additional equipment required for a complete installation.
- B. Basis of Design: UNIRAC NXT UMount
- C. Provide all components for a complete roof mounted rail-system compatible with the provided PV modules suitable for mounting on an angled metal seam roof. Provide all accessories inclusive of clamps, rails, rail splices, wire management clips, rail and Clamp end caps, roof attachments, etc.
- D. Wind Loading:
 - 1. The system design shall be assessed by the provider for ability to meet the local standards for wind design speeds for the particular application.
 - 2. Coordinate maximum wind load with Structural Engineer.

E. System Electrical:

1. The modules shall be electrically connected by “quick-connect” electrical connectors specified and provided by the PV provider to create electrical strings according to Drawings.
2. Each system shall have at least one inverter. Full specifications of the inverter shall be supplied as part of the system documentation.
3. Each system shall have AC wiring. The AC wiring shall run from the output of the inverter(s) to a disconnect, then to a local panel.
4. Wiring shall be sized for a maximum of 3% voltage drop.

2.6 CONDUIT

- A. Refer to Section 260533 for raceways and boxes.
- B. Shall use steel conduit listed per UL 6, UL 1242, UL 797 (as appropriate), except for tracking modules. Weathertight EMT installations shall be allowed for DC wiring in weather-protected areas.
- C. Conduit shall use expansion joints on long conduit runs.
- D. Conduit shall not be installed on photovoltaic modules.

2.7 CONDUCTORS

- A. Alternating Current (AC) Conductors:
 1. Refer to Section 260519 for electrical power conductors and cables.
- B. Direct Current (DC) Conductors:
 1. Conductors shall be 1000V minimum, aluminum photovoltaic (PV) wire.
 2. If Exposed: Shall be USE-2, UF (inadequate at 60°C [140°F]), or SE, 90°C [194°F] wet-location rated and sunlight-resistant (usually for tracking modules).
 3. If in Conduit: Shall be RHW-2, THWN-2, or XHHW-2 90°C [194°F], wet-location rated.

2.8 GROUNDING

- A. All applicable components of the solar energy electrical power generating system must be grounded per latest NEC requirements.
- B. DC Ground-Fault Protector:
 1. Listed per UL 1703.
 2. Comply with requirements of the NEC.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install all equipment and labelling in accordance with manufacturer's recommendations and as required by NEC or other applicable codes. A permanent label shall be posted near the main PV disconnect switch that contains the following information per NEC 690-52.
 - 1. Operating current (system's maximum power current)
 - 2. Open-circuit current
 - 3. Operating voltage (system's maximum power voltage)
 - 4. Open-circuit voltage
- B. Coordinate photovoltaic system installation and interconnection to the utility's electrical system with the local electrical utility including utility request information/forms.
- C. Roof mounted photovoltaic modules shall only be installed on areas of roof identified on Drawings.
- D. Coordinate all roof attachments and roof penetrations with the roof installer and roof system manufacturer instructions.
- E. Rack-mounted photovoltaic modules shall be installed in accordance with the manufacturer's installation instructions. Provide module level shutdown wireless modules for rapid shutdown in compliance with NEC rapid shutdown requirements.
- F. Provide a instrumentation as listed in Part 2 providing photovoltaic system electrical generation, sensors, and a data logger/monitoring system.
- G. Provide connections and cabling between computer and PV System for smart solar electrical monitoring.
- H. Prior to system start-up, ensure no copper wire remains exposed with the exception of grounding wire as allowed in certain circumstances per manufacturer's instructions.
- I. Wiring Installation: Workers shall be made aware that photovoltaic modules will be live and generating electricity when there is any ambient light source and shall take appropriate precautions. Utilize on-site measurements in conjunction with engineering designs to accurately cut wires and layout before making permanent connections. Locate wires out of the way of windows, doors, openings, and other hazards. Ensure wires are free of snags and sharp edges that have the potential to compromise the wire insulation. All cabling shall be mechanically fastened. If the system is roof-mounted, it shall have direct current ground fault protection according to NEC. Ensure breakers in combiner section are in the off position (or fuses removed) during combiner box wiring.
- J. Instrumentation: Install instruments as recommended by the manufacturer. Locate control panels inside a room accessible only to qualified persons.
- K. Provide safety signage per NEC.

3.2 GROUNDING

- A. As indicated on the Drawings and Section 260526. Maintain a single point, negative ground throughout the Photovoltaic System.
- B. Bond photovoltaic system modules/collectors, racks, and equipment in accordance with NEC and per system manufacturer's installation instructions.

3.3 INSTALLATION

- A. Provide all AC, DC and communication cabling as required for a complete and operational system and install in accordance with NEC requirements.
- B. The roof shall be inspected for compliance with requirements by an approved inspector. Minor repairs or services, if any, will be completed prior to installation.
- C. Install roof racking system in accordance with the roof rack manufacturer's recommendations.
- D. The inverter shall then be installed. After one or more inspectors have verified the work, the inverter shall be connected to AC service.
- E. Access, Pathways, and Smoke Ventilation: Access and spacing requirements must be observed in order to: ensure access to the roof, provide pathways to specific areas of the roof, provide for smoke ventilation opportunities area, and, where applicable, provide emergency access egress from the roof.
- F. Provide data cable from inverters as required to central server.
- G. An acceptance test and commissioning procedure provided by the provider shall be performed.
- H. Installation AC wiring and raceways in accordance with Division 26 specifications, as shown on the drawings, and as recommended by the equipment manufacturer.
- I. Wiring on roof where required shall be metal conduit and installed in accordance with Division 26 specifications.
- J. Provide wiring clips as required for wiring between photovoltaic modules/collectors and roof racking.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Perform in accordance with manufacturer's recommendations. Prior to initial operation, inspect the solar energy electrical power generation system for conformance to drawings, specifications, and NEC. In addition, include the following:
 - 1. Visual Inspection and Tests:
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.

- c. Verify required area clearances.
- d. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method or performing thermographic survey after energization.
- e. Verify the correct operation of all sensing devices, alarms, and indicating devices.
- f. Verify that all cable entries from top of junction boxes are sealed per junction box rating.
- g. Verify all connections and integrity of printed circuit boards in all applicable junction boxes.

3.5 TESTING

- A. When installation is complete, inverter manufacturer's representative shall test entire installation in the presence of the owner. Coordinate test a minimum of 1 week in advance with the owner. Test shall include as a minimum:
 - 1. Complete inverter function test ensures that each individual and stacked inverter set performs all features as specified.
 - 2. Record and provide a brief written summary of all programmed values and set points after completing final testing for each inverter. Also provide written record of all current and voltage readings.

3.6 DEMONSTRATION AND TRAINING

- A. Provide 4 hours of operating instructions for entire PV energy system, including operation of inverters and other features. Instruct Owner in removing and installing panels, including wiring and all connections. Provide Owner with written instructions and procedures for seasonal shutdown and startup activities for all components of the PV Power System.

END OF SECTION 263100

SECTION 263213 – ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged engine-generator sets for standby power supply with the following features:
 - 1. Fuel: Natural Gas
 - 2. Location: Outdoor
 - 3. NFPA 110 defined Type 1, Class U, Type 10 compliant system

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.
 - 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).

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.
- B. Rating: 100% of nameplate rating for duration of any power outage with no derate.
- C. Fuel System: Natural Gas
- 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
 - 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. 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.
- D. Provide circuit breakers in the quantity and size of the transfer switches unless otherwise noted.
- E. Provide a permanently fastened pad lockable hasp accessory for each breaker.
- F. 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.
- 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 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 be designed to maintain the interior enclosure temperature above 40° F per NFPA 110 or be provided with an interior unit heater to maintain the interior enclosure temperature above 40°F. The housing shall have hinged 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% ± 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.

2.8 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.
 - 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)
 - 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.

2.9 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.
 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.

PART 3 - EXECUTION

3.1 OUTDOOR PREPARATION

- A. Provide pad for each generator as detailed on the drawings.

3.2 NATURAL GAS GENERATOR SCOPE OF WORK

- A. The Electrical Contractor shall coordinate the generator fuel and piping requirements with the Plumbing Contractor.
- B. The Plumbing Contractor shall provide fuel piping to generator including shut-off valve, gas regulator, flexible piping, and all required final connections.

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.
- 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.20A circuit breaker in closest panel and connect to enclosure unit heater, if required, with 2#10 + 1#10 GND in 3/4" conduit unless otherwise noted. Provide breaker and wire sizes recommended by manufacturer.
- L. 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.
- M. Install a sign at the main switchgear noting the location of the emergency generator: ie: "NOTE: EMERGENCY GENERATOR LOCATED OUTSIDE OF BUILDING".
- N. 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.
- 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

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.

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
- 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.
- 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.
- 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

SECTION 263605 – DUAL PURPOSE MANUAL TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Dual Purpose Manual Transfer Switches with Integrated Load Bank and Generator Quick Connects

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code
- B. NEC Article 700.3 (F)
- C. UL 1008 Listed for Optional Standby Transfer Switches (Manual Transfer Switches)
- D. IEC 60947-6-1 Low – Voltage Switchgear and Controller
- E. NFPA 99 – Essential Electrical Systems for Health Care Facilities
- F. IEEE Standard 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- G. UL 508 – Industrial Control Equipment
- H. UL 891 – Switchboards
- I. NEMA ICS 1 – General Standards for Industrial Control and Systems
- J. NEMA ICS 2 – Standards for Industrial Control Devices, Controllers, and Assemblies
- K. 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. Record actual location of transfer switches.
- C. Operation Data: Include instructions for operating equipment. Include instructions for operating equipment under emergency conditions when engine generator is running.
- D. 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 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 indicated.

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. Basis of Design:
 - 1. ASCO – 300 Series (3MTDQ)
- B. Alternate Manufacturers:
 - 1. Tystar Dual Purpose Docking Station Model DBDS-5
 - 2. ESL Power Systems TripleSwitch 3-way Manual Transfer Switch Series 3141-M

2.2 RATINGS

- A. Amperage: Refer to the Transfer Switch Schedule or Power Riser Diagram.
- B. Voltage System: Refer to the Transfer Switch Schedule or Power Riser Diagram.
- C. Switched Poles: Refer to the Transfer Switch Schedule or Power Riser Diagram.
- D. Solid Neutral or Switched Neutral: Refer to the Transfer Switch Schedule or Power Riser Diagram.
- E. Short Circuit Current Rating: Refer to the Transfer Switch Schedule or Power Riser Diagram. Provide short circuit current rating to match the Main Switchboard if not noted on the Transfer Switch Schedule or Power Riser Diagram.

2.3 MECHANICALLY HELD TRANSFER SWITCH

- A. The transfer switch unit shall be manually operated and mechanically held. The switch shall be mechanically interlocked to ensure only one of three possible positions, Source 1, Source 2, or Center Off Fused disconnect type switches shall not be acceptable.
- B. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.
- C. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts.

- D. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors.
- E. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- F. Where neutral conductors must be switched, the MTDQ shall be provided with fully- rated neutral transfer contacts.
- G. Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.
- H. The MTDQ shall be tested in accordance with UL 1008 for transfer switches. Switch ratings of 260 amperes and less shall have endurance rating of 6000 cycles, 400 ampere shall have endurance rating of 4000 cycles, and 600 – 3000 ampere shall have endurance rating of 3000 cycles.

2.4 MANUAL OPERATIONS PROVISIONS

- A. The transfer switch shall be arranged for manually actuated manual operation.
- B. The manual transfer shall be actuated via a mechanical operating mechanism.
- C. The manual operating handle shall be capable of external operation without opening the enclosure door.
- D. It shall have the same contact to contact speed as automatic operation
- E. There shall be three positions for manual operation:
 - 1. Connected to Source 1 (preferred)
 - 2. Connected to Source 2 (alternate)
 - 3. Connected to center off (disconnected position)
- F. Switch position when connected to Source 1, or Source 2 shall be pad – lockable.

2.5 ENCLOSURE

- A. Free standing, floor mounted, gauge formed steel frame construction.
 - 1. Exterior Locations: NEMA Type 3R
- B. Enclosures shall be code gauge steel as per UL 50 with ANSI #61 powder coat finish.
- C. Accessory 44G – Enclosure Heater
 - 1. A 125 watt enclosure heater with transformer and thermostat (adjustable from 30° to 140 ° F) shall be provided for exterior locations.
 - 2. Heater shall be wired to the load terminals and not require 120V power.

2.6 ADDITIONAL FEATURES

- A. Mechanical position indicators (yellow) visible to the operator shall be included for Source 1 (preferred), Source 2, (alternate), and Center Off (disconnected).
- B. Auxiliary position indicating contacts, rated 10 amps, 250 Vac shall be provided consisting of one closed when the MTDQ is connected to Source 1 (preferred), and one contact closed when the MTDQ is connected to Source 2 (alternate)
- C. A form A contact shall be provided to indicate switch is in the Center Off (disconnected) position.
- D. A Load Dump disconnect breaker shall be provided between source 1 of the transfer switch and 16 Series Outlets for Load Bank Connection.
- E. Auto Start Destination Toggle Switch shall be provided to allow for the user to select which generator the ATS will start when the engine start signal is sent from the ATS.
- F. Dual Purpose Manual Transfer Switch with Integrated Quick Connects contains 16 Series quick connects which provides a connecting means for connecting a portable generator or a load bank.
- G. Generator quick connects are located on the front or back side of this MTDQ.
 - 1. For 400A and below models, there shall be one (1) row of up to five (5) series single pole connections.
 - 2. For 600A - 800A models, there shall be two (2) rows of up to five (5) single pole connections.
 - 3. For 1000A-1200A models, there shall be three (3) rows of up to 5 single pole connections.
 - 4. For 1600A models, there shall be four (4) rows of up to 5 single pole connections.
 - 5. For 2000A models, there shall be five (5) rows of up to 5 single pole connections.
 - 6. For 2500A models, there shall be seven (7) rows of up to 5 single pole connections.
 - 7. For 3000A models, there shall be eight (8) rows of up to 5 single pole connections
- H. Load Bank connects are located on the front side of this MTDQ. Neutral connections are not provided for Load Bank connections.
 - 1. For 400A and below models, there shall be one (1) row of up to four (4) series single pole connections.
 - 2. For 600A - 800A models, there shall be two (2) rows of up to four (4) single pole connections.
 - 3. For 1000A-1200A models, there shall be three (3) rows of up to four (4) single pole connections.
 - 4. For 1600A models, there shall be three (3) rows of up to 4 single pole connections.
 - 5. For 2000A models, there shall be five (5) rows of up to 4 single pole connections
 - 6. For 2500A models, there shall be seven (7) rows of up to 4 single pole connections
 - 7. For 3000A models, there shall be eight (8) rows of up to 4 single pole connections
- I. All electrical connectors shall be 16 Series cam type single pole connectors, available color coded as per industry standard practice:
 - 1. 240V and below: phase 1 = black, phase 2 = red, phase 3 = blue (if required).
 - 2. 480V: phase 1 = brown, phase 2 = orange, phase 3 = yellow.
 - 3. Ground shall always be green.

4. Neutral shall always be white.
5. A minimum of 25% Ground is provided for portable generator and load bank connections.

2.7 OPTIONAL FEATURES

- A. Provide the following optional features:
 1. Accessory 171 Base Package Bundle – Two form C contacts shall be connected to customer terminal block that operate when Source 1 and Source 2 voltage is present at transfer switch terminals. The following indicators shall be provided:
 - a. Load Connected to Source 1 (Green).
 - b. Load Connected to Source 2 (Red).
 - c. Source 1 Available (Green).
 - d. Source 2 Available (Red).
 - e. Load Disconnect (Yellow)

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 transfer 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 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

3.4 TESTS AND CERTIFICATION

- A. The complete MTDQ shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure compliance with the specification requirements.
- B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- C. The MTDQ manufacturer shall be certified to ISO 9001: 2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001: 2008.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Check inter-wiring and instruct Contractor on corrections required.
- B. Prepare and start systems as required.

3.6 DEMONSTRATION

- A. Provide systems demonstration as required.
- B. Demonstrate operation of transfer switch in normal, and emergency modes.

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 263605

SECTION 264313 – DISTRIBUTION SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SCOPE

- A. Work under this section consists of furnishing all materials necessary for the execution and complete installation of surge protective devices.

1.2 REFERENCE STANDARDS

- A. Underwriters Laboratories, Inc. Standard No. 1449 (latest edition)
- B. IEEE Standard C62.45, C62.41 (latest edition)
- C. National Electrical Code Article 240-21 (Equipment complying with tap conductor rules) and Article 110-9 (Interrupting Capacity)
- D. Manufacturer shall be ISO 9001 Certified

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. Submit 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 rating, dimensions and finishes with the specific item or model number highlighted.
 - d. Data sheet shall also include type of unit and the protected panels name or reference number (I.E. Type H2 – Panels CP1, CP2 & CP3)

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of equipment.
- C. Maintenance Data:
 - 1. Routing 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.

1.5 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Units shall consist of parallel connections only. Series components are optional. All MOV's shall be individually fused to provide system redundancy.
- B. The surge protective device must be UL listed under the (UL 1449, Most Recent Edition), UL 1449, Third Edition Voltage protection rating, and short circuit current rating must be clearly stated.
- C. Metal Oxide Varistors (MOVs) are to be utilized as the primary suppression components.
 - 1. Suppression systems shall not employ any other technologies such as gas tubes, spark gap devices, selenium devices or filters.
- D. Enclosures:
 - 1. Units located in indoor environments shall be provided in heavy duty NEMA 1, or better rated enclosure.
 - 2. Units located in outdoor environments shall be provided in heavy duty NEMA 3R or better rated enclosure.
 - 3. Refer to the drawings to determine whether units are for indoor or outdoor applications.
 - 4. Refer to the drawings to determine whether units are for flush mount or surface mount installations.
 - 5. SDP units may be installed internal/integral to the gear.
- E. All units shall have active indicator lights, which shall extinguish when protection has failed.
- F. Units must be supplied as part of distribution equipment where UL listed as a complete assembly.
- G. Disconnect switch/overcurrent protection: See Part 3.1 for more information regarding this feature.
- H. 10-year unconditional warranty.

2.2 TYPE H1 UNIT – NON-CRITICAL, SERVICE ENTRANCE APPLICATIONS

- A. Voltage Rating: 480/277V, 3-phase, 4-wire.
- B. Application: Distribution Switchboard or Panelboard
- C. Minimum Modes of Protection: Common or Normal: L-N, L-G, L-L, & N-G

- D. Maximum UL 1449 Voltage Protection Ratings (VPRs) for L-N, L-G, and N-G Modes of Protection: 1200 volts.
- E. I-nominal Rating: 20kA
- F. Minimum Acceptable Single Pulse Surge Current Capacity: 240,000 amps per phase
- G. The following models are acceptable:
 - 1. Square D Company Model SSP04EMA24
 - 2. Eaton Model SPD250480Y2K
 - 3. Siemens Model TPS4E13250X2
 - 4. ASCO Model 460277YP25ACAE10

2.3 TYPE H2 UNIT – NON-CRITICAL LOAD APPLICATIONS

- A. Voltage Rating: 480/277V, 3-phase, 4-wire
- B. Application: Distribution Switchboard or Panelboard
- C. Minimum Modes of Protection: Common or Normal: L-N, L-G, L-L, & N-G
- D. Maximum UL 1449 Voltage Protection Ratings (VPR's) for L-N, L-G, & N-G Modes of Protection: 1200 volts.
- E. I-Nominal Rating: 20kA
- F. Minimum Acceptable Single Pulse Surge Current Capacity: 160,000 amps per phase
- G. The following Models are acceptable:
 - 1. Square D Company Model SSP04EMA16
 - 2. Eaton Model SPD160480Y2K
 - 3. Siemens TPS4E13200X2
 - 4. ASCO Model 430277YP20ACSJ20

2.4 TYPE H3 UNIT – NON-CRITICAL LOAD APPLICATIONS

- A. Voltage Rating: 480/277V, 3-phase, 4-wire.
- B. Application: Distribution Switchboard or Panelboard
- C. Minimum Modes of Protection: Common or Normal: L-N, L-G, L-L, & N-G.
- D. Maximum UL 1449 Voltage Protection Ratings (VPRs) for L-N, L-G, and N-G Modes of Protection: 1200 volts.
- E. I-nominal Rating: 20kA
- F. Minimum Acceptable Single Pulse Surge Current Capacity: 120,000 amps per phase

- G. The following models are acceptable:
 - 1. Square D Company Model SSP04EMA12
 - 2. Eaton Model SPD120480Y2K
 - 3. Siemens TPS4E13150X2
 - 4. ASCO Model 430277YP20ACSJ20

2.5 TYPE L1 UNIT – NON-CRITICAL SERVICE ENTRANCE APPLICATIONS

- A. Voltage Rating: 120/208V, 3-phase, 4-wire.
- B. Application: Distribution Switchboard or Panelboard
- C. Minimum Modes of Protection: Common or Normal: L-N, L-G, L-L, & N-G.
- D. Maximum UL 1449 Voltage Protection Ratings (VPRs) for L-N, L-G, and N-G Modes of Protection: 1200 volts.
- E. I-nominal Rating: 20kA
- F. Minimum Acceptable Single Pulse Surge Current Capacity: 240,000 amps per phase
- G. The following models are acceptable:
 - 1. Square D Company Model SSP02EMA24
 - 2. Eaton Model SPD250208Y2K
 - 3. Siemens Model TPS4C13250X2
 - 4. ASCO Model 460120YP25ACAE10

2.6 TYPE L2 UNIT – NON-CRITICAL LOAD APPLICATIONS

- A. Voltage Rating: 120/208V, 3-phase, 4-wire.
- B. Application: Distribution Switchboard or Panelboard
- C. Minimum Modes of Protection: Common or Normal: L-N, L-G, L-L, & N-G.
- D. Maximum UL 1449 Voltage Protection Ratings (VPRs) for L-N, L-G, and N-G Modes of Protection: 1200 volts.
- E. I-nominal Rating: 20kA
- F. Minimum Acceptable Single Pulse Surge Current Capacity: 160,000 amps per phase
- G. The following models are acceptable:
 - 1. Square D Company Model SSP02EMA16
 - 2. Eaton Model SPD160208Y2K
 - 3. Siemens Model TPS4C13200X2
 - 4. ASCO Model 430120YP20ACSJ20

2.7 TYPE L3 UNIT – NON-CRITICAL LOAD APPLICATIONS

- A. Voltage Rating: 120/208V, 3-phase, 4-wire.
- B. Application: Distribution or Branch Circuit Panelboard
- C. Minimum Modes of Protection: Common or Normal: L-N, L-G, L-L, & N-G.
- D. Maximum UL 1449 Voltage Protection Ratings (VPRs) for L-N, L-G, and N-G Modes of Protection: 1200 volts.
- E. I-nominal Rating: 20kA
- F. Minimum Acceptable Single Pulse Surge Current Capacity. 120,000 amps per phase
- G. The following models are acceptable:
 - 1. Square D Company Model SSP02EMA12
 - 2. Eaton Model SPD120208Y2K
 - 3. Siemens Model TPS4C13150X2
 - 4. ASCO Model 430120YP15ACSJ20

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The unit shall be installed in accordance with the manufacturer's printed instruction. All local and national codes and regulations must be observed.
- B. Units shall be installed of the same voltage rating as the intended protected equipment.
- C. Units shall be internally/integrally, surface, or flush mount to match the intended protected equipment.
- D. Installation of Units:
 - 1. Install separately enclosed units immediately adjacent to or within the protected panel with the shortest possible lead length without any unnecessary elbows, bends or turns. Where conduit is necessary to install lead connection conductors, leads shall be installed in conduit as required.
 - 2. Provide a dedicated 3-pole branch circuit breaker in all protected panels for connection. Circuit breaker size and wire size shall be per manufacturer recommendation. Connect leads to the load side of the circuit breaker.
 - 3. If space is not available in protected panel, provide a 3-pole disconnect switch between the protected panel and the SPD for connection. Fuse and wire size shall be per manufacturer recommendation. Connect leads from the disconnect switch to the main bus (or distribution bus), whichever allows for the shortest total lead length) of the protected panel.

3.2 LOCATIONS

- A. See the power riser drawings for all SPD unit locations and types.

END OF SECTION 264313

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.
- 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.

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.
 - 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 unless otherwise noted
 - D. CRI: 80 or greater unless otherwise noted

- 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.

- 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.
- 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.
- 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. Replaced 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

SECTION 265561 – THEATRICAL LIGHTING & CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Theatrical Luminaries
- B. Dimmers and Control Units

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:
 - 2. Reference to Specification Section.
 - 3. A list of all luminaries arranged in order of luminaire designation.
 - 4. Luminaire data sheets to indicate features, finishes, and dimensions with the specific items or model number highlighted.
 - 5. Accessory sheets to indicate optional items added to the luminaries with the specific item or model number highlighted.
 - 6. Color samples of luminaries that require color selection.
 - 7. Lamp data sheets with the specific item or model number highlighted.
 - 8. Power panel and all associated equipment with the specific item or model number highlighted.
 - 9. All warranties for luminaries, ballasts, and lamps.
 - 10. Wiring diagrams for power, signal, and control wiring.

1.3 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of dimmer outlets and circuiting arrangements in project record documents.
- C. Operation Data:
 - 1. Instructions for operating lighting control system.
 - 2. Document ratings of system and of each major component.
- 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.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA “National Electrical Code” for components and installation.
- B. Installer Qualifications: an experienced installer who has installed systems of similar scope and function as the units required for this project.
- C. Manufacturer Qualifications: Firms experienced in manufacturing equipment of the types and capacities indicated that have a record of successful in-service performance.
 - 1. Service Center: Select a manufacturer of dimmers and lighting controls that maintains a service center capable of providing training, parts, and emergency maintenance and repairs at the project site.
- D. Electrical Components, Devices, and Accessories: Listed and labeled defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Comply with UL508, “Industrial Control Equipment”
- C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.6 VARIATION

- A. While the components, units and arrangements described herein and shown on the drawings indicate specific details for the realization of the stage lighting control system, the bidder may propose alternate details and components which will fulfill the functional parameters of the envisioned system only after having obtained, in writing, from the Engineer, permission to do so 10 days prior to bid date.
- B. In such event, bidders shall submit an exact set of specifications, no less detailed than these and following the same general outline, together with a detailed statement indicating paragraph by paragraph how the equipment and arrangements offered differ from the specifications in this bid request.

1.7 WORK TO BE PERFORMED

- A. Electrical - The Electrical Contractor shall be responsible to provide and install all circuiting as per plans to light fixtures.
 - 1. Provide and install all low voltage wiring from new dimmer cabinet to control locations, as per plans, including all terminations.
 - 2. Program all DMX addresses before installing luminaires. Coordinate addresses with Owner and Control Manufacturer.
 - 3. Provide rigging, battens, spotlight cages, auxiliary steel and required mounting hardware to mount lighting instruments for the front of house and stage electric positions.

1.8 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURER'S

- A. Basis of Design: Lehigh Electric Products Company
- B. Alternate Manufacturers:
 - 1. Electric Theatre Controls (ETC)

2.2 MANUFACTURER'S REQUIREMENTS

- A. Equipment specified herein shall be the sole responsibility of single manufacturers who shall fabricate all assemblies and sub-assemblies in his own shop (this includes all dimming and control equipment).

2.3 FACTORY CHECK-OUT, DEMONSTRATION, AND INSTRUCTION

- A. Provided by the manufacturer of the specified equipment.
- B. Provide complete visual and operational check-out of the system at least 4 hours of demonstration of the complete lighting system and operating instruction to the Owner and/or his representative. This demonstration time shall be mutually agreed upon by the 2 parties involved but shall take place no longer than 30 days after the system is completely installed.

2.4 LIGHTING RIGGING

- A. Provide rigging, battens, auxiliary steel spotlight cages, and required mounting hardware to mount lighting instruments for the front of house and stage electric positions.
- B. Provide support pipes for the front-of-house theatrical lighting and stage electrics.

2.5 FIXTURES AND DISTRIBUTION EQUIPMENT, GENERAL

- A. Metal Parts: Free from burrs and sharp corners and edges.
- B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- C. Fixture Doors and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without the use of tools. Arrange doors, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
- D. Pigtail: Factory wired, minimum 36" long, 3-wire cord and connector assembly with cord encased in woven fiberglass or silicone tubing.

- E. Plug Connectors: Two-pole, 3-wire, 20-A. Type as listed.
- F. Pipe Clamps: Malleable iron, suitable for clamping fixtures or items to pipe from 3/4" to 2" in OD. Arrange fixture clamps for horizontal rotation of yoke for aiming and equipped with a T-bolt to lock alignment.
- G. Safety Cables: Heavy duty, flexible steel, 30" nominal length, with spring clip at one end and steel ring at other.
- H. Fixture Ventilation Openings: Baffled against light leaks.
- I. Fixture Operating Controls and Handles: Thermally insulated.
- J. Lenses: Borosilicate glass in silicone mountings.
- K. Color Filter Frame Holder: Attached to front of fixture.
- L. Fixture Yoke: Rigid metal, arranged for vertical aiming of unit and equipped with T-bolt or hand screw to lock alignment.

2.6 FIXTURES AND DISTRIBUTION EQUIPMENT

- A. General: Listed under UL 1573.
- B. Standard Features: Equip each fixture with pigtail and connector, yoke with pipe clamp, safety cable for batten mounting, and filter holder.
- C. Ellipsoidal Spotlights - LED: Multicolor, RGBAL, 220W LED fixture with 16-bit control of intensity and color.
 - 1. Housing: Die-cast aluminum housing construction. Gel frame holder. Approximate weight of 25 pounds.
 - 2. Light Engine: RGBAL; 50,000-hour LED life to L70. 91 LEDs.
 - 3. Light engine accepts tool free interchangeable barrels. Rotating barrel. Lens tubes secured with two tool free thumb screws. Optional lens options to include: 14, 19, 26, 36, and 50° fixed lenses and 15-30 and 25-50° zoom lenses.
 - 4. Body Color: Black powder coat finish.
 - 5. Rating: 100-240volt 50/60Hz Universal Power Input. Electrical & Data: PowerCon® in and out connections. 5-pin DMX in and out. Requires power from non-dim source.
 - 6. Shutters: Four 21-gauge, adjustable spring steel shutters.
 - 7. Fixture to be complete with 5' power cord, safety cable, yoke, and c-clamp.
 - 8. Quiet fan cooled operation and suitable for operation within an ambient temperature range of -20°C to 45°C range. IP-20 rating for dry location use.
 - 9. Fixture to be MET tested and labeled and meet UL 1573 and UL 8750 LED standards.
 - 10. Include a five-line OLED display with 4 button user-interface.
 - 11. DMX and RDM compatible.
 - 12. Provide: 6 – E-910FC LED ellipsoidal spotlights (2 @ 19°, 2 @ 26°, and 2 @ 36°)
- D. Spotlight Cages:
 - 1. Welded steel frame with metal mesh sides, tops and bottom. Spotlight cage assembly to include a hinged bottom access panel and spotlight mounting brackets.
 - 2. Sized to contain 3 ellipsoidal spotlights.

3. Attach to the building structure and mount one receptacle box with each cage.
 4. Paint black.
 5. Provide: Two LPSC3L., three fixture spotlight cages.
- E. Par Spotlight: Multicolor, RGBAL, 185W LED fixture with 16-bit control of intensity and color.
1. Housing: Die-cast aluminum housing construction. Gel frame holder. Approximate weight of 15 pounds.
 2. Light Engine: RGBAL; 50,000-hour LED life to L70. 48 LEDs.
 3. Provided with interchangeable medium (24° beam angle) and wide (73° beam angle) lenses.
 4. Body Color: Black painted finish.
 5. Rating: 100-240volt 50/60Hz Universal Power Input. Electrical & Data: PowerCon® in and out connections. 5-pin DMX in and out. Requires power from non-dim source.
 6. Fixture to be complete with 5' power cord, safety cable, yoke, and c-clamp.
 7. Quiet fan cooled operation and suitable for operation within an ambient temperature range of -20°C to 45°C range. IP-20 rating for dry location use.
 8. Fixture to be MET tested and labeled and confirm with UL 1573 and UL 8750 LED standards.
 9. Include a five-line OLED display with 4 button user-interface.
 10. DMX and RDM compatible.
 11. Provide: 4 – P-56FC LED par spotlights.
- F. Wash Lighting:
1. Conform to UL 1573, "Stage and Studio Lighting Units"
 2. Standard Features: Equip each luminaire with 5' length pigtail with Edison plug connector, yoke with pipe clamps, safety cable for batten mounting, and filter holder.
 3. Wash Light: 620 watts rated. Provide c-clamps and safety cables as described above.
 - a. Five color RGBAL 620W LED wash light.
 - b. 20° x 40° beam angle optics with filter installed.
 - c. Compatible with DMX, Artnet, sACN, and RDM protocols.
 - d. 2800K - 6500 K color temperature.
 - e. DMX and Powercon in and out connections mounted on both ends.
 - f. Dimensions: B-2805FC: 70" L x 8" H x 8" D.
 - g. Supplied with power cables as required for installation as shown on plans.
 - h. Lux. B-2805FC: 2320 lux @ 5 meters with filter installed.
 4. Provide:
 - a. Stage Electric 1: 3 - B-2805FC LED wash lights.
 - b. Stage Electric 1: 3 - B-2805FC LED wash lights.
- G. Receptacle Plug-in Boxes:
1. Welded steel, minimum of 16-ga, with removable cover.
 2. Receptacles: Two flush mounted, parallel blade receptacles.
 3. Receptacles Rating: Grounded 20A.
 4. Ground lug.
 5. Mounting: Surface or pipe as noted.
 6. Provide: Front of House spotlight cages: 2 – LEPB-1PBGF-S (one plug box per cage.).
- H. Connector Strips: Factory-wired wireways and receptacle assembly.
1. Wireway: 16-ga steel construction with a 4.25" x 2.5" cross section and screw covers. Length as required.

2. Receptacles: The flush PBG receptacles shall be evenly distributed along the length and circuited as scheduled. See part numbers below for quantity of receptacles and circuiting.
 3. Receptacles Wiring: Connect to terminal blocks with 125°C, cross-linked, polyethylene insulated wire.
 4. Ground lug.
 5. Mounting: Steel mounting straps located at 5' intervals to wrap around wireway and attach to 1-1/2" (2" OD max.) Schedule 40 pipe. Single pipe mounting.
 6. Electrical contractor to provide 1-1/2" Schedule 40 black iron pipe with all joints made with bolted thru couplings. Stage electric pipe shall be dead hung and securely fastened to the building structure as approved by the architect.
 7. Provide:
 - a. Stage Electric 1: LCS-1P-25-6PBGF/3C.
 - b. Stage Electric 2: LCS-1P-25-4PBGF/2C.
- I. Gridiron Junction Boxes: Grid mounted box with terminals for contractor termination of load circuits.
1. Box: Welded steel, minimum of 16 gauge, with removable cover.
 2. Terminal Blocks: Molded barrier type with screw lugs to suit supply conductors.
 3. Ground lug.
 4. Mounting: Surface
 5. Provide:
 - a. Stage Electric 1: LJB6.
 - b. Stage Electric 2: LJB6.
- J. Multi-conductor Cable: Flexible, multiple conductor cable with an SO jacket.
1. Length as required to interconnect the connector strip to the grid junction box.
 2. Minimum 12-ga, stranded wire with color-coded insulation.
 3. Two wires per circuit plus ground and 10% spares.
 4. Strain relief grips installed at each end of cable.
 5. Provide:
 - a. Stage Electric 1: 1 – LBC6.
 - b. Stage Electric 2: 1 – LBC6.
- K. Miscellaneous Parts:
1. DMX cables.
 - a. 15 @ 5'
 - b. 6 @ 10'.
 2. PowerCon to PowerCon cables.
 - a. 10 @ 5'
 - b. 6 @ 10'.
 3. DMX Terminator plugs: 4
- ## 2.7 LIGHTING CONTROL SYSTEM
- A. Description: Microprocessor-based, modular system consisting of dimmer and control modules operated from remote-control stations and a control console.
1. Comply with UL508
 2. Comply with USITT DMX 512 for data transmission.
- B. Master Station: DTM-TS Series self-contained, programmable dimming controller.

1. Mechanical:
 - a. Faceplate to be aluminum with no visible fasteners and available in a black, white, or beige painted finish. Station to mount in a factory furnished backbox.
 - b. Station shall include a 7", 800 X 480 pixels, color LCD display with LED backlighting providing touch interface operation.
 - 1) Display to include adjustable brightness control.
 - 2) Display automatically dims to a reduced level and/or displays a preselected idle screen when the station has been inactive over a user programmable period.
 - 3) User selectable screen color and configuration options.
 - 4) Cleaning mode to disable the display screen for 15 seconds.
 - 5) Tab based user interface for quick, easy to navigate control operation.
 - c. Station shall operate using a graphic user interface with the control features (buttons, faders, etc.) graphically displayed on the LCD. Station display shall not include any mechanical switches, potentiometers, or similar mechanical devices.
 - d. Control wiring: 2 shielded pair (Belden 9729) plus 3 - #14 wires.
 - e. Low voltage control wiring to auxiliary control stations.
 - f. The station has a digital output and requires two shielded pairs (Belden #9729) plus 3-#14 wires.
 - g. Each DTM-MA series master station requires a 24V DC power input.
 - h. USB port: Station control settings shall be user programmable using a PC based software system to provide off-line editing of the control settings and labels.
 - i. DMX in and DMX out ports for DMX capture operation.
 - j. All stored control data and settings shall be retained indefinitely if power is lost using non-volatile ferroelectric RAM. The station shall return to the previous control status once power is restored.
2. The master station shall provide the following control functions:
 - a. Playback up to 24 control actions which are any combination of control functions and up to 18 presets.
 - 1) Record 18 presets plus Full and Off at the station without requiring any external controls.
 - a) Presets are programmed setting the channel controllers to the required control levels and recording those settings to a preset. Presets may be modified and copied to another preset.
 - i) Each channel slider displays the channel name plus a numerical and graphical control level indication.
 - ii) Channel level intensity may be adjusted by touching the slider at the current control level and sliding your finger up or down to set the desired level or instantly changed by touching the slider scale at the desired level.
 - iii) Channels viewed by pages in groups of 10 channels.
 - iv) Channel controllers provide temporary, manual control of an active preset. The changes are not permanent unless stored.
 - b) Full: Fades all channels to user programmable levels over a user selected fade time.
 - c) Off: Fades all channels to blackout over a user selected fade time.
 - d) Master controller adjusts the channel levels in an active preset. The override is temporary and does not change the preset levels stored in memory.

- e) Each preset has a programmable fade time from 0 seconds to 60 minutes with the active fade time indicated in the display. Repressing the preset button accelerates an active fade.
- 2) Lock or unlock the station memory, access to the station operation, and remote entrance stations. Lock function is secured by an access code.
- 3) Clean function to allow cleaning the station LCD display without impacting active light settings.
- 4) Optional S-MIO module provides system control of shades, use presets to output a dry contact signal, and interface with multiple daylight and occ sensors.
- 5) Direct DMX control with up to one DMX universe (512 channels) per master station.
- 6) Station programming functions are accessed via a PC. Programmable settings shall include:
 - a) Channel dim/non-dim/fluorescent/LED control operation, high/low level trim settings for each channel, and patching one DMX universe to the 512 station channels.
 - b) Program preset and channel names.
 - c) Preset fade times from 0 seconds to 60 minutes.
 - d) Assignment and configuration settings for daylight and occ sensors.
 - e) Set control channel configuration options:
 - i) Incandescent - standard forward phase dimming.
 - ii) Non-dim control.
 - iii) Fluorescent – control of forward phase fluorescent ballasts.
 - iv) Multi-color LED control: Fixtures with multi-color LEDS (RGB, etc.) are controlled with the DMX output using discrete controllers or the color mode option which includes a station color pallet configurator.
 - f) Astronomical timeclock function with up to 25 events and 25 holidays to activate presets, enable/disable occupancy sensor control operation, enable/disable photocell control operation, and activate the lights-out warning alert function.
 - g) Auto-sequence mode for linked playback of preset groups with fade times.
- 7) Multiple room control of up to 8 areas with independent or linked room control with partitions.
- 8) DMX capture mode
 - a) Station shall accept a DMX in signal from an external DMX device and ‘capture’ the current DMX levels for future recall by the DTM-TS station.
 - b) Station shall automatically sense a DMX input signal and display a ‘DMX-In’ button on the station display. In capture mode, the current DMX values may be stored to a preset in any area.
 - c) Station shall include an RDM thru feature, which allows the input console to interface with any RDM devices downstream of the station.
- 9) SITE tab displays the current control setting status in each area.
 - a) Displayed controls: active preset, remote stations lock/unlock status, enable/disable occ and daylight sensors, and timeclock lights out function status.

- b) Status of each control feature, including presets, may be modified at this display.
 - 10) Focus check control of all DMX channels.
 - 11) Wireless mobile app permits system control using iOS or Android based phones/tablets. Wireless operation requires adding optional Solitaire S-Com control module and a wireless access point router. With wireless control, the following control features shall be provided:
 - a) Recall and activate all DTM-MA master presets by area, virtual button control features (partition control status, remote station lock/unlock, auto-sequence operation mode, and shade control) plus Full, and Off. The controller shall display all presets and virtual buttons names for each area.
 - b) Master raise/lower control of the active preset.
 - c) Set and record selected channel levels in a preset.
 - d) Select and record color selections and control levels of RGBXX fixtures using the master station color mode function. RGB color selection provided using either the scroll or color palette function with additional colors added and controlled via the color mode function.
 - e) System shall be user name and password protected with a maximum of three simultaneous users per system S-Com.
- 3. The DTM-MA station shall be mounted in a surface-mounted steel panel with a hinged, locking cover. Black painted finish. This panel shall also include a power supply and 4-way opto-splitter/merger control module.

C. E-Flex Power Panel:

- 1. Description: Microprocessor-based, modular system consisting of relays, control modules, and remote stations.
 - a. UL and cUL LISTED (508 and 924).
 - b. Comply with USITT DMX 512-A for data transmission (ANSI E1.11-2008 and ANSI E1.20-2010).
- 2. Cabinet:
 - a. Mechanical:
 - 1) Cabinets shall contain 8 relay-controlled circuits.
 - 2) 18-ga steel, surface mounted, NEMA 1, IP20 rated panel with a removable screw cover. Textured, black powder coat finish.
 - 3) Provide a removable interior shield that covers all line voltage components. When the cabinet's cover is removed, only the class II low voltage components will be accessible.
 - 4) Dimensions: E-Flex 8: 16.25" H x 12" W x 3" D.
 - 5) Mounting: Surface mounted.
 - b. Electrical:
 - 1) Universal input voltages: 90V to 277V AC and 47 to 63Hz. UL/cUL 508 and 924 listed.
 - 2) Power connection: Provide terminals for 8 – 20A power inputs and outputs.
 - c. Environment:
 - 1) Ambient temperature operating range from 0°C to 40°C.
 - 2) Indoor use only.
 - d. Relays:
 - 1) Single pole, mechanically held, latching style relays rated for 120V to 277V operation.

- 2) Each relay includes an LED status indicator and an integral manual operation switch.
- 3) Relays must maintain their control setting upon loss of power.
- 4) Relays must be UL rated for use with electronic ballasts (EB rated).
- 5) Minimum load type power ratings in the 120V to 277V operating range:
Electronic ballast: 16A, Tungsten: 20A, Standard ballast: 20A or Resistive: 50A.
- e. Control Inputs:
 - 1) Each panel shall accept DMX/RDM in and DMX pass-thru operation.
 - 2) Programmable DMX start address function.
- D. Provide:
 - 1. 1 – DTM-MA DMX master station mounted in a wall-mounted enclosure with a hinged locking cover.
 - 2. 1 – 4W optosplitter/merger mounted in the DTM panel enclosure.
 - 3. 4 – Pipe mounted DMX/out DMX receptacles. Receptacles to be mounted at Stage Electric 1, Stage Electric 2, FOH spotlight cage 1 and FOH spotlight cage 2.
 - 4. One console receptacle. Surface mounted enclosure with one DMX/in receptacle.
 - 5. 1 – E-flex power panel with 8 relay-controlled circuits.

2.8 FINISHES

- A. Manufacturers' standard, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment according to manufacturer's written instructions.
- B. Install rigging, battens, auxiliary steel and required mounting hardware to mount lighting instruments for the front of house and stage electric positions.
- C. Set permanently mounted items plumb and level and square with ceilings and walls.
- D. Mount and connect fixtures. Arrange as indicated or so each fixture, each dimmer and the House Control, can be operated and the system demonstrated in all operating modes.
- E. Mounting of Equipment: Conform to manufacturer's instructions and Section 26 05 29.
- F. Mounting heights indicated are to bottom of unit for suspended items and to center of unit for wall-mounted ones.

3.2 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 26 05 53.
- B. Label each fixture, lighting outlet, and dimmer module with a unique designation. Make designations on elevated components readable from the floor.

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between control devices as specified in appropriate Section 260180 for hard wired connections. Install wiring in raceway except cable and plug connections.
- B. Wiring in Enclosures: Bundle, train, and support.

3.4 FIELD QUALITY CONTROL

- A. Manufacturers Field Services: Arrange and pay for the service of a factory-authorized service representative to test, adjust, and program the lighting control system.
- B. Test Labeling: upon satisfactory completion of tests and observations, apply a label to tested components indicating test results, date, and responsible organization and person.
- C. Schedule visual and mechanical inspections and electrical tests with at least 14 days advanced notification.
- D. Visual and Mechanical Inspections: Include the following: Inspect each fixture, outlet, module, and item of equipment for defects, finish failure, corrosion, and physical damage, NRTL labeling and nameplate.
 - 1. Exercise and perform operational tests on mechanical parts and operable devices according to manufacturer's instructions or routine functional operation.
 - 2. Check tightness of electrical connections with torque wrench calibrated within the previous 6 months. Use manufacturers recommended torque values.
 - 3. Verify proper protective device settings and fuse types and ratings.
- E. Electrical Tests: Perform according to manufacturer's instructions. Exercise caution testing devices containing solid-state components. Insulation resistance tests of conducting parts of control components and connecting supply feeder and control circuits. Minimum acceptable insulation resistance is 100 megohms or greater.
 - 1. Continuity tests of circuits.

3.5 CLEANING AND ADJUSTING

- A. Remove paint splatters and other spots, dirt and debris. Repair scratches and mars of finish to match original finish. Clean fixtures, devices and equipment internally and externally using methods and materials as recommended by manufacturers.

3.6 DEMONSTRATION

- A. Demonstrate functions, features, and adjustments for each fixture with fixture energized and operating with the indicated lamp.
- B. Demonstrate the system to prove compliance with requirements.

3.7 COMMISSIONING

- A. Operational Tests: Energize lighting controls systems, program controls, and check controlled outlets for light levels. Program test scenes so every fixture is tested throughout its operating

range with the installed lamp. Check programmed function at each house control, entry, and emergency light control station. Adjust components and revise installation to correct deficiencies.

- B. Correct deficiencies and retest deficient items. Verify by the system tests that specified requirements are met.

3.8 TRAINING

- A. Personnel Training: Provide and pay for the services of a factory-authorized service representative to demonstrate the system and train Owner's personnel. Provide training for operating, testing, troubleshooting and general maintenance of the system.
 - 1. Provide a minimum of one 4-hour session with at least 2 weeks advance notice.
 - 2. Provide documentation of sessions to Architect/Engineer with signatures of at least 3 Owners Representatives present at demonstration.

END OF SECTION 265561

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.

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.
- 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.

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 unless otherwise noted
- D. CRI: 70 or greater unless otherwise noted
- 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.
 - 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.
- 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.
- 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

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.

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. Main Telecommunications Ground Bus:
 - 1. Material: 1/4" tinned copper busbar
 - 2. Size: 4"x12" min
 - 3. Mounting: Insulated stand-off
 - 4. Location: Service Entrance Telecommunications Backboard.
- B. Additional Telecommunications Ground Bus:
 - 1. Material: 1/4" tinned copper busbar
 - 2. Size: As required
 - 3. Mounting: Insulated stand-off
 - 4. Location: All MDF and IDF rooms in the project
- C. 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

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.

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. Main Telecommunications Ground Bus (MTGB): Connect to the following:
 - 1. CATV entrance ground lug with #6 copper – green insulation.
 - 2. Telephone entrance protector with #6 copper – green insulation.
 - 3. Main service entrance equipment ground bus with #3/0 copper – in 1-1/2" conduit.
 - 4. MDF ladder rack with #6 copper – green insulation.
 - 5. Each MDF rack/cabinet ground bus with #3/0 copper – in 1-1/2" conduit.
 - 6. Each IDF secondary grounding bus bar in the project with #1/0 copper – green insulation in 1-1/4" conduit.
 - 7. Building structural steel with #6 copper – green insulation.
- B. IDF Rack Ground Bus Bar (TGB) shall connect to the following:
 - 1. Each IDF rack/cabinet in IDF with #6 copper – green insulation. Provide lateral bonding between all IDF Racks.
 - 2. Building structural steel with #6 copper – green insulation.
- C. 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.
- D. Comply with Section 260526, 270500 and applicable details on plans.
- E. Provide connections to the main ground bus on all backboards, telephone line protectors, IDF Racks and MDF Racks in the project.
- F. Connect ground buses with cables per Specification Section 260526, 270500 and applicable details on plans.

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. Comply with all installation requirements of Section 260529.

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 or wireways 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.
- 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. 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 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

SECTION 271100 – COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment Racks/Enclosures
- B. Backboards
- C. Wire Management
- D. Stand Off Brackets
- E. Cable Ladder
- F. 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.
- 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 FLOOR MOUNTED EQUIPMENT RACK – TWO POST RACK

- A. Manufacturers:
 - 1. Middle Atlantic Products

2. Hubbell Premise Wiring
3. Hoffman
4. Great Lakes

B. Basis of Design – Middle Atlantic Products

1. Model: MK-19-45
2. Type: 19" cable management rack
3. Compliance: EIA/TIA 310D
4. Overall Dimensions:
 - a. Height: 84.25"
 - b. Width: 24"
 - c. Depth: 24"
5. Useable Height: 45 rackspaces
6. Construction: Fully welded
7. Weight Capacity:
 - a. Evenly Distributed with Base Securely Fastened: 500 pounds.
 - b. Evenly Distributed with Base Securely Fastened and Top Braced to Structural Building Component: 800 pounds.
8. Cable Management Rings: Steel, multi position, front mount, 20 places.
9. 7" Obround Cable Pass-Through Openings:
 - a. Front: 8 cable holes with plugs
 - b. Each Side: 8 obrounds
 - c. Back: 12 obrounds
10. Integrated Top Cable Trough: Front and rear
11. Multiple Raised Cable Lacing Points: Cable management
12. Cable Fastening Straps: Hook and loop
13. Front Cable Feed-Through Hole Plugs: 8
14. Rack Screws: 10-32 threads, 100
15. Finish: Phosphate pretreated, black textured powder coat

C. Power Outlet Strips:

1. Provide (2) AC power outlet strips with 12 NEMA 5-20R (20A) outlets and line cord vertically mounted in enclosure, Model PDT-1220C-NS with adapter bracket Model PB-5A.

D. Provide the following accessories for **ALL** racks unless otherwise noted on the Drawings:

1. Horizontal lacer bars, Model LBP-1X
2. Horizontal cable managers, Model HCM-X
3. Cable ladder adapter, Model MK-LA
4. Rackmount Cable Tray (one rackspace), Model HCT-1
5. Rackmount Cable Tray (two rackspaces), Model HCT-2
6. Vented center mount shelf, Model U2MS
7. All equipment mounting hardware required.

2.2 FLOOR MOUNTED EQUIPMENT ENCLOSURE – FOUR POST RACK/CABINET

A. Manufacturers:

1. Middle Atlantic Products
2. Atlas Soundolier

3. Hoffman
 4. Great Lakes
- B. Basis of Design – Middle Atlantic Products
1. Model: WRK-44-32
 2. Type: 19" gangable equipment rack
 3. Compliance:
 - a. EIA/TIA 310D
 - b. Seismic Certified: Seismic certified to 1997 UBC and 2001 CBC Seismic Zone 4 and 2000 IBC, 2003 IBC, 2002 ASCE Standard 7, and 2003 NFPA 5000 Seismic Use Group III lateral force requirements for protecting 900 pounds of essential equipment in upper floor installations when used with optional WRK-Z4 seismic floor anchor brackets with Ip value of 1.5.
 4. UL Listed: US
 5. Overall Dimensions:
 - a. Height: 83.13"
 - b. Width: 24.25"
 - c. Depth: 32.63"
 6. Useable Dimensions:
 - a. Height: 77.13 rackspaces
 - b. Depth: 30.75"
 7. Construction: Fully welded
 8. UL Listed Weight Capacity: 2,500 pounds (static load capacity is 10,000 lb)
 9. Materials:
 - a. Top and Bottom: 14-ga steel
 - b. Horizontal Braces: 16-ga steel welded to integral structural side panels of 16-ga steel giving 1/8" thick structure
 - c. Rear Door: 18-ga steel
 10. Finish of Structural Elements: Black textured powder coat
 11. Rackrail:
 - a. Two pairs of fully adjustable, 11-ga steel rackrail with tapped 10-32 mounting holes in universal EIA spacing
 - b. Finish: Black e-coat
 - c. Rackspaces: Numbered
 12. Top and Bottom: Vertical slotted vent pattern
 13. Removable Rear Knockout Panel:
 - a. 1/2", 3/4", 1", and 1-1/2" electrical knockouts installed in top and bottom
 - b. 5/8" BNC knockouts for UHF/VHF antennas installed in top
 14. Grounding and Bonding Stud: 1/4-20 by 1" threaded, installed in base, allows installation to conform to NEC
- C. Power Outlet Strips:
1. Provide (2) AC power outlet strips with 12 NEMA 5-20R (20A) outlets and line cord vertically mounted in enclosure, Model PDT-1220C-NS with adapter bracket Model PB-5A.
- D. Provide the following accessories for **ALL** racks unless otherwise noted on the Drawings:
1. Front Doors: Reinforced 16-ga steel, large perf, 64% open area, Model LVFD-44
 2. Vented Rear Doors: 16-ga steel, large perf, 64% open area, Model MW-LVFD-44

3. Removable Keylocked Side Panels: 16-ga steel with recessed lift handles, Model SPN-44-312
4. Top Panels: 16-ga steel with 3-1/2" service plate, accepts four 4-1/2" fans, Model MW-4FT
5. Integrated Fan Tops:
 - a. Proportional speed, thermostatic fan control
 - b. Fans: Four 4-1/2", 50 cfm quiet fans
6. Caster Base:
 - a. Standard Caster Base, Model CBS-WRK-32:
 - 1) Adds 1" to overall height
 - 2) Total Weight Capacity of 4 Casters: 1,300 pounds
 - 3) UL Listed: US and Canada
 - b. Fine-Floor-Friendly Caster Base, Model CBS-WRK-32R:
 - 1) Adds 1 inch to overall height
 - 2) Total Weight Capacity of 4 Casters: 700 pounds
7. Rail Bracket Adapters, Model RBA-W44-1:
 - a. Allow for mounting of blank or other panels vertically between rackrail brackets
 - b. 44 space enclosures
8. Lacer Strip: 11-ga steel, heavily perforated, 77" long, Model LACE-44-OWP
9. Additional Rail Kit: 11-ga steel, 10-32 threaded, in pairs, includes hardware, Model WRK-RR-44
10. Seismic compliancy floor anchor kit
11. Ganging hardware
12. Copper buss bar
13. Document pocket
14. Leveling Feet:
 - a. Isolated or Non-isolated
 - b. 3/8" threaded steel, adjustable from top or bottom
 - c. Adds 1/4" to 1" to rack overall height
15. Inner platform base, Model BS-WRK-32
16. Door latch
17. All equipment mounting hardware required
18. Blank and vented panels to fill rack

E. Provide the following accessories **WHERE INDICATED** on the drawings:

1. Standard Caster Base, Model CBS-WRK-32:
2. Seismic compliancy floor anchor kit
3. Adjustable telescoping rackshelf, Model VSA-2744.
4. Heavy Duty Drawer, Model D3

2.3 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.

2.4 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.
 - 3. Horizontal cable management duct (Models HS14C or HS24C) 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.

2.5 WALL MOUNTED STAND-OFF BRACKETS

- A. Manufacturers:
 - 1. Middle Atlantic Products
 - 2. Hubbell Premise Wiring
 - 3. Hoffman
- B. Basis of Design: Middle Atlantic Products HPM Series Mounts.
- C. Heavy duty two vertical steel only spaced to mount 19" wide panels and chasses constructed to EIA-310-D dimensions with base plate and bracing.
 - 1. Universal keyhole mounting for left or right swing
 - 2. Mounting holes must provide options to mount directly to racks or walls
- D. Mounting Rails: 2 drilled and tapped to EIA-310-D dimensions.
 - 1. 10-32 rack screws included
- E. Mounting Space: Racks units as required plus 20% spare. Provide multiple brackets totaling the indicated number of units hinged for future termination without dismounting patch panel.
- F. Provide the following Accessories:
 - 1. Optional lid to protect equipment from dust, Model HPM-LID

2.6 CABLE LADDER/RUNWAY

- A. Manufacturers:
 - 1. Middle Atlantic Products
 - 2. Hubbell Premise Wiring
 - 3. Hoffman

4. Great Lakes

- B. Basis of Design: Middle Atlantic Products CLB-6 or CLB-10 Series Cable Ladders
- C. CLB-6 ladder sections shall be 71" long x 12" wide x 1.5" thick, rungs shall be 1" x .5" x 11.25" tube. Ladder section shall have 6 rungs on 12" centers.
- D. CLB-10 ladder sections shall be 119" long x 12" wide x 1.5" thick, rungs shall be 1" x .5" x 11.25" tube. Ladder section shall have 10 rungs on 12" centers.
- E. Design Requirements:
 - 1. Ladder shall be constructed of ASTM A570 structural steel finished in a durable black powder coat.
 - 2. Each CLB series ladder section shall be individually boxed with handles.
 - 3. CLB Series cable ladder shall have up to 187 lb. weight capacity per foot based on a 4 ft. support span.
 - 4. Cable ladder shall be classified by UL in the US.
 - 5. Cable ladder shall be GREENGUARD Gold Certified.
 - 6. Cable ladder shall comply with the requirements of RoHS EU Directive 2002/95/EC.
 - 7. Cable ladder shall be manufactured by an ISO 9001 and ISO 14001 Registered Company.
 - 8. Cable ladder shall be warranted to be free from defects in material and workmanship under normal use and conditions for the lifetime of the product.
- F. Provide the following accessories as required for each application:
 - 1. Adjustable Horizontal Splice Hardware
 - 2. Ladder End Splice Hardware
 - 3. 90-Degree Horizontal Tee-Splice Hardware
 - 4. Adjustable Ladder End Splice Hardware
 - 5. Adjustable 90-Degree Tee-Splice Hardware
 - 6. Triangle Wall Support Brackets
 - 7. Cable Ladder End Drop with 3 Cable Spools
 - 8. Cable Ladder Side Drop with 3 Cable Spools
 - 9. Ladder Wall Clamps
 - 10. Ladder Wall Supports
 - 11. Ladder Center Support Brackets
 - 12. Slotted Ladder Support Hardware with Ceiling Hang Kit
 - 13. Ladder End Support Hardware
 - 14. Plastic Cable Spools
 - 15. Ladder End Caps
 - 16. Cable Ladder Bonding Kit

2.7 TELEPHONE CONNECTING BLOCKS

- A. Manufacturers:
 - 1. Hubbell Premise Wiring
 - 2. The Siemon Company
 - 3. Systimax GigaSpeed Products
 - 4. Leviton

- B. Basis of Design – Hubbell Premise Wiring 110BLK Series cross connect
- C. Design Requirements:
 - 1. Category 5E-110 wiring blocks shall be available in 50-pair, 100-pair, and 300-pair capacities, with or without detachable standoff legs.
 - 2. Wiring blocks shall be available as kits that include wiring blocks, label strips, and the appropriate quantity of connecting blocks for termination to full capacity.
 - 3. Connecting blocks shall also be available separately.
 - 4. Connecting blocks shall accommodate a 5-pair punch-down tool designed specifically for the purpose of Category 5E termination.
 - 5. Wiring blocks and connecting blocks shall be constructed of UL94-V0 rated high-impact flame-retardant polycarbonate blend thermoplastic.
 - 6. Wiring blocks shall accept 26-22 AWG solid or stranded conductors
 - 7. Wiring blocks shall accept conductor insulation diameters of .050" to .070" maximum.
 - 8. Wiring blocks and connecting blocks shall have a temperature rating of 14°F to 140°F with up to 95% non-condensing humidity.
 - 9. Wiring blocks shall have through-openings to permit rear cable entry and direct routing to each point of termination.
 - 10. Connecting blocks shall connect to the wiring block with a locking force of 35-lb minimum.
 - 11. Connecting blocks shall withstand a minimum of 200 re-terminations without degradation to electrical or mechanical performance.
 - 12. IDC contacts in the connecting blocks shall be a spring temper phosphor bronze alloy, .032" thickness, with 100 micro-inches minimum solder plate (60% tin/40% lead) at the wire contact area.
 - 13. IDC contact termination towers on the connecting blocks shall have tapered pair-splitting features to aid wire insertion and minimize pair un-twist. IDC towers shall also have high-definition color-coding.

2.8 TELEPHONE CABLE CONNECTIONS

- A. Main Service Entrance: Provide Type '66' blocks, Category 5E, mounted on stand-off brackets from backboard with all cross-connect cables.
- B. Intermediate (Closet and/or Consolidation Point) Connections: Provide UTP rack mount patch panels to match those used for data.

2.9 BUILDING ENTRANCE TERMINALS

- A. Manufacturers: Circa Model 1880 Series
- B. Protective Devices: Refer to Lightning Protection.
- C. Cabinet Boxes: Galvanized steel with removable endwalls, 24" wide, 24" high, 6" deep. Provide plywood backboard inside cabinet for mounting telephone termination devices.
- D. Cabinet Fronts: Steel, surface type, concealed hinge, double doors, and flush lock keyed to match branch circuit panelboard.

- E. Finish: Gray baked enamel.

2.10 LIGHTNING PROTECTION

- A. Manufacturers:
 - 1. Circa
 - 2. Siecor
 - 3. ITW Linx
- B. Basis of Design – Circa Building Entrance Terminals:
 - 1. 1880 Series for 110 punchdown
 - 2. 1890 Series for 66 punchdown
- C. Design Requirements:
 - 1. Protection shall be available in 25 pair, 50 pair or 100 pair
 - 2. Equipped with an internal fuse link
 - 3. Equipped with a removable splice chamber should the terminal fuse within a multiple configuration
 - 4. Stackable to allow for future service expansion
 - 5. External ground connectors accept 6-14 AWG ground wire
 - 6. Accommodates industry standard 5 pin protection module
 - 7. Designed to exceed the requirements set forth in UL 497
- D. Provide protection for number of pair in service cable entering premises.
- E. Provide on each cable or pair entering or leaving the premises.

2.11 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 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 in cabinets and 4-post racks which contain more than 12 jacks. Provide blank filler plates as required to fill rack.
- D. Support raceways, cabinets, and all other equipment in accordance with manufacturer's instructions.
- E. Install backboards and cabinets plumb and attach securely to building wall at each corner and additional as necessary to obtain a firm mounting.
- F. Provide full assembly of all racks, equipment enclosures, cabinets and file servers with all accessories installed.
- G. 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.
- C. Connect ground buses with cables per Specification Section 260526, 270500 and applicable details on plans.

END OF SECTION 271100

SECTION 271300 – COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fiber Optic Cables and Equipment
- B. Telephone 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. BISCI – 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 Interchangeability 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.
- 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.

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.
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 single-mode 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 OS2 single-mode 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 Splice-On Connectors to maintain the 25-year fiber warranty. PN#'s FCLCF900M50G6OK, FCLCF900SM6PK.

C. Fiber optic cable shall be terminated with LC OS2 Single-mode connectors to fiber adapter panels mounted in Hubbell FCR series fiber optic enclosures with at least 50% spare capacity.

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. Single-mode 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. 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.
 11. All standard mating and interface dimensions for LC connectors shall comply with ANSI/TIA/EIA-604-10 (FOCIS 10).
 12. Ferrule outside diameter for LC single-mode connectors shall be 1.2483mm to 1.2497mm.
 13. LC ferrule tip shall have a PC spherical radius of approximately 7.0 mm radius for single-mode versions.
 14. Delivered connectors shall be individually bagged with the dust cap installed to protect from contamination.
 15. Delivered connectors shall have the disposable clamp activation wedge element pre-installed onto the connector body.
 16. 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.
 17. LC connector strain relief boot shall be a Telcordia style slotted design for maximum flexural strain relief.
 18. Strain relief boot shall be black for multimode, and yellow for single-mode.
 19. LC connectors shall be available individually bagged in packs of 12.
 20. Pre-polished LC fiber connectors, when properly installed onto qualified cable, shall meet the 10 Gb/s Ethernet performance requirements of IEEE802.3.
 21. 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'.
 22. Pre-polished LC fiber connectors, properly installed onto qualified cable, shall exceed the mechanical and environmental performance requirements of Telcordia GR-1081-CORE.
 23. 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.
- 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: (Single-mode)
 - 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: Single-mode
 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. Single-mode cables shall perform at minimum to the attenuation, bandwidth, and distance application parameters in the table below.

Single-mode 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 DFHPCLCL (SM) Series patch cords.
- C. Fiber optic cable shall be terminated with LC OS2 Single-mode 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 Intermateability 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 Single-mode 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. Single-mode 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.

2.6 TELEPHONE HIGH PAIR COUNT BACKBONE CABLES

- A. Manufacturers:
1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Belden
 5. Berk-Tek, Inc.

- B. Cables must meet or exceed Category 5E requirements.
 - 1. All high pair count cable shall conform to the requirements of ANSI/TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard.
 - 2. All high pair count cable shall consist of 24AWG thermoplastic insulated copper conductors that are formed into one or more units of unshielded twisted pairs.
 - 3. All high pair count cable shall be assembled into binder groups of 25 pairs or part thereof following the standard industry color code (ANSI/ICEA S-80-576).
 - 4. All high pair count cable shall be identified by distinctly colored binders and assembled to form the core.
 - 5. All high pair count cable shall have a sheath that consists of an overall thermoplastic jacket and may contain an underlying metallic shield and one or more layers of a dielectric material applied over the core.
 - 6. All high pair count cable shall be Plenum or Riser Rated in accordance with NEC Article 770, UL Subject 1666, and UL Subject 910.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cable. Check raceways 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 installed above accessible ceilings between ceiling mounted devices or conduit stub-ups 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. 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 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 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.
- 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 cabling system premises network which meets the channel performance as described in ANSI/TIA/EIA-568-C.2.

END OF SECTION 271300

SECTION 271501 – COMMUNICATIONS HORIZONTAL CABLING – CATEGORY 6A

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. UTP Cables and Equipment
- B. Modular Jacks, Modules and Faceplates
- C. Surface Mount Boxes
- D. Phone Plates
- E. 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. BISC – 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;
 - 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.
- 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 6A UTP RACK MOUNT PATCH PANELS FOR DATA

- A. Manufacturers:
 - 1. Hubbell Premise Wiring
 - 2. The Siemon Company – Z-Max Series
 - 3. Systimax GigaSpeed Products – XIOD Series
 - 4. Leviton – C1255-H48 w/ 6AUJK-R*6
- B. Basis of Design – Hubbell Premise Wiring HPJA24/HPJ6A48 Series category 6A Jack Panel Kits.
- C. Design Requirements:
 - 1. Category 6A patch panels shall be standard Jack Panel Kits, 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 Kit frames shall be black powder coated 14-ga steel with rolled edges top and bottom for proper stiffness.
 - 3. Jack Panels shall accommodate a minimum of 24 ports for each rack mount unit (1 RMU = 1.75").
 - 4. Jack Panels shall be designed for 4-pair, 100-ohm balanced unshielded twisted pair (UTP) cable.
 - 5. Jack Panels shall terminate 26-22 AWG solid conductors, with maximum insulation diameter of 0.050".
 - 6. Jack Panels shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.
 - 7. Jack Panels shall have individual port identification numbers on the front and rear of the panel.
 - 8. Jack 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.
 - 9. Jack Panel contacts shall be constructed of Beryllium copper for maximum spring force and durability.

10. Jack Panel Contact plating shall be a minimum of 45 micro-inches of precious metal in the contact area over 50 micro-inch of nickel.
11. Rear Jack Panel contacts shall be Phosphor Bronze with 100 micro-inch lead free tin plating over nickel.
12. HPJ6A series panel adapter ports shall accept optional hinged dust covers.
13. HPJ6A series panel adapter ports shall accept snap-on icons for specific identification.
14. Space above the adapter ports shall be available for additional labeling per ANSI/TIA/EIA-606-B.
15. Category 6A panels shall be backward compatible with existing Category 3, 5, 5e, and 6 cabling systems for fit, form, and function.
16. Panels shall accept a clip-on rear cable management support bar to provide cable strain relief.
17. Panels shall include integrated label holders with white designation labels and a clear cover for each 6-port adapter.
18. Panel adapters shall accept strain relieving stuffer caps, one cap per port.
19. 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 6A panels shall meet or exceed Category 6A transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568.2-D, Transmission Performance Specifications for 4-Pair 100-ohm Category 6A Cabling.
3. The manufacturer shall provide Category 6A component compliance certificates from third party testing organizations upon request.
4. Panels shall be UL LISTED 1863 and CSA certified.
5. Panels shall be tested to 150% of IEEE 802.3bt DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
6. The 4-connector channel test configuration shall utilize Category 6A patch panels, Category 6A jack, and Category 6A patch cords, from the same manufacturer, with qualified Category 6A cable.
7. The 4-connector channel performance margins in the table below shall be guaranteed. Conditions of requirement No. 6 above apply.

Electrical Parameter (1 - 500MHz)	Guaranteed Margins to Category 6A
Insertion Loss	3%
NEXT	4dB
PSNEXT	5dB
ACR	4dB
PSACR	5dB
Return Loss	4dB
ACRF	6dB
PSANEXT	4dB
PSAACRF	4dB

- E. Provide patch panel port quantity as required for cables + 20% spare unless otherwise noted on the drawings.

2.2 CATEGORY 6A UTP CABLES FOR DATA

- A. Manufacturers:
1. Hubbell Premise Wiring
 2. The Siemon Company – 9C6P4-A5-(XX)-ARIA Series
 3. Systemax GigaSpeed Products – X10 3291B Series
 4. Berk-Tek, Inc. – 11101842 SST Series
- B. Basis of Design – Hubbell Premise Wiring HCL6A Low Od Category 6A patch cords
- C. Design requirements
1. Cable construction shall be four twisted pairs of 23 AWG insulated solid conductors, surrounded by an outer jacket.
 2. Cable shall be manufactured with an “X”-shaped pair-divider along the center to maintain separation of individual pairs.
 3. Cable shall have a non-conductive isolation wrap to suppress ANEXT.
 4. Conductor diameters shall be $0.022" \pm .0003"$ solid copper.
 5. Conductor insulation diameter shall be $0.042" \pm .0005"$ FEP.
 6. Outer jacket diameter shall be $0.260" \pm .008"$ low smoke PVC, with a nominal wall thickness of $0.016"$.
 7. Cable shall be marked: “HUBBELL PREMISE WIRING NEXTSPEED CATEGORY 6A UTP -- [P/N] -- 4PR 23AWG – C(UL)US CMP OR (UL) CMP-LP (0.6A) -- E255553-E --VERIFIED (UL) CAT 6A ANSI/TIA 568-C.2 AND ISO/IEC 11801 -- PATptnd.info/Hubbell/ -- ZZ/YY (DDJNN) -- *** FT”
 8. Frequency of marking shall be every 2.0'.
 - a. ‘ZZ’ represents the month of manufacture.
 - b. ‘YY’ indicates the year of manufacture.
 - c. ‘DDJNN’ indicates the job number.
 - d. ‘***FT’ 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' reel in box.
- 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 6A transmission requirements specified in ANSI/TIA/EIA-568-C.2-1 and shall be tested through 750 MHz.
 3. Worst-case cable performance shall be +7.0 dB headroom over current TIA/EIA standards limits for ANEXT loss.
 4. Cable shall be UL and c (UL) listed.
 5. Cable shall exceed IEEE 802.3bt DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.

6. Cable shall meet or exceed the 4-connector channel performance requirements of Category 6A, per the ANSI/TIA/EIA-568-C.2-1 standard.
7. The 4-connector channel test configuration shall utilize Category 6A jacks and patch panels, with Category 6A patch cords, from the same manufacturer, with qualified Category 6A cable.
8. The 4-connector channel performance margins in the table below shall be guaranteed provided the configuration satisfies requirement No. 7 above.

Electrical Parameter (1 - 500MHz)	Guaranteed Margins to Category 6A
Insertion Loss	3%
NEXT	4dB
PSNEXT	5dB
ACR	4dB
PSACR	5dB
Return Loss	4dB
ACRF	6dB
PSANEXT	4dB
PSAACRF	4dB

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 C6A10SPBK
- 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 6A 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)

2.4 CATEGORY 6A 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 HC6A Series category 6A patch cords

C. Design Requirements:

1. Category 6A 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 6A patch cable, with 26 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 6A patch cords shall be backward compatible with existing Category 3, 5, 5e, and 6 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 6A patch cords shall be channel performance balanced with Hubbell category 6A jacks, patch panels, and punch-down blocks.
3. Category 6A patch cords shall meet or exceed Category 6A component transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-C.2 standard.
4. The manufacturer shall provide Category 6A 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. Category 6A patch cords shall meet or exceed the 4-connector channel transmission performance requirements of Category 6A, per ANSI/TIA/EIA-568-C.2 standard.
8. The 4-connector channel test configuration shall utilize Category 6A patch panels, blocks, and jacks, with Category 6A patch cords, all from the same manufacturer, with qualified Category 6A cable.
9. The 4-connector channel performance margins in the table below shall be guaranteed, provided the configuration satisfies requirement No. 8 above.

Electrical Parameter (1 - 500MHz)	Guaranteed Margins to Category 6A
-----------------------------------	-----------------------------------

Insertion Loss	3%
NEXT	4dB
PSNEXT	5dB
ACR	4dB
PSACR	5dB
Return Loss	4dB
ACRF	6dB
PSANEXT	4dB
PSAACRF	4dB

- 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 6A MODULAR JACKS

- A. Manufacturers:
1. Hubbell Premise Wiring
 2. The Siemon Company – Z-Max Series
 3. Systimax GigaSpeed Products – X10 Series
 4. Leviton – 6AUJK-R*6
- B. Basis of Design – Hubbell Premise Wiring HJU6A Series category 6A Cobra Lock Tool-Less jacks
- C. Design Requirements:
1. Category 6A jacks shall be a standard 8-position, RJ-45 style, un-keyed, IEC 60603-7-compliant receptacle.
 2. Jacks shall be designed for 4-pair, 100 ohm balanced unshielded twisted pair (UTP) cable.
 3. Each jack shall be single unit construction, to snap fit into keystone opening (.676" X .575").
 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. Jacks shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.
 7. Jacks shall have shielding properties to protect from electromagnetic interference and alien cross-talk (ANEXT).
 8. Jack housings shall fully encase and protect printed circuit boards and IDC contacts.
 9. Modular jack contacts shall accept a minimum of 750 mating cycles without degradation of electrical or mechanical performance.
 10. Jack contacts shall accept insertion of a FCC-Standard RJ-11 plug without degradation of electrical or mechanical performance with re-insertion of a FCC-Standard RJ-45 plug.
 11. Jack contacts shall be formed flat for increased surface contact with mated plugs.

12. Jack receptacle contacts shall comply with Level A reliability requirements for connecting hardware as defined by IEC 60603-7 series of standards.
13. Contact plating shall be a minimum of 45 micro-inches of precious metal plating in the contact area over 50 micro-inch of nickel.
14. Jack termination shall only require a cable stripper and industry standard flush cutters.
15. Jack termination method shall not utilize a 110 impact termination tool or any manufacturer specific tools.
16. Jack termination completion shall be able to be performed by hand.
17. Wire manager should be provided to organize and secure wire prior to termination completion.
18. Jack termination shall lock in place with an audible snap and require a use of a small screwdriver to unlock.
19. Jacks shall have the Category 6A designation, visible from the front when installed.
20. IDC contacts shall be Phosphor Bronze with 100 micro-inch lead free tin plating over nickel.
21. Jacks shall terminate 24-22 AWG solid conductors.
22. Jacks shall terminate insulated conductors with outside diameters up to .050".
23. Jacks shall be compatible with ANSI/TIA/EIA-606-A color code labeling.
24. Jacks shall be available in various colors to meet specific customer applications.
25. Jacks shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.
26. Category 6A jacks shall be backward compatible with existing Category 3, 5, and 5e category 6 cabling systems for fit, form, and function.
27. Jacks shall be manufactured in a Trade Agreements Act (TAA) Country

D. Performance Requirements:

1. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
2. Category 6A jacks shall meet or exceed Category 6A transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568.2-D, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
3. The manufacturer shall provide Category 6A component compliance certificates from third party testing organization upon request.
4. Jacks shall be UL LISTED 1863 and CSA certified.
5. Panels shall be tested to 150% IEEE 802.3bt DTE Power specification with no degradation of performance or materials.
6. Category 6A jacks shall meet or exceed the 4-connector channel performance requirements of Category 6a, per the ANSI/TIA/EIA-568.2-D standard.
7. The 4-connector channel test configuration shall utilize Category 6A jack panels, Category 6A jack, and Category 6A patch cords, from the same manufacturer, with qualified Category 6A cable.

Electrical Parameter (1 - 500MHz)	Guaranteed Margins to Category 6A
Insertion Loss	3%
NEXT	4dB
PSNEXT	5dB
ACR	4dB
PSACR	5dB
Return Loss	4dB

ACRF	6dB
PSANEXT	4dB
PSAACRF	4dB

2.7 STAINLESS STEEL FACE PLATES AND UNLOADED MODULES IN KITCHEN AND DISHWASHING AREAS

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
 - 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 PLASTIC FACE PLATES AND UNLOADED MODULES IN OTHER THAN KITCHEN AND DISH WASHING AREAS

A. Manufacturers:

1. Hubbell Premise Wiring
2. The Siemon Company
3. Systimax GigaSpeed Products
4. Leviton

B. Basis of Design – Hubbell Premise Wiring IMF Series Modular Faceplates and Modules.

C. Design Requirements:

1. IMF Series Faceplates:
 - a. Faceplates shall be constructed of Molded ABS.
 - 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.
 - h. Color shall match the wiring device color. Verify with Architect.
2. IMF Series Modules:
 - a. Faceplate Modules shall be constructed of high impact, UL94 V-0 rated thermoplastic.
 - b. Modules shall be compatible with IMF 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 IMF Series Faceplate shall accept (3) 1U modules
 - e. Double Gang IMF 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
- 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**

2.9 CATEGORY 6A 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 HJ6A Series category 6A 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.

2.10 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.

2.11 CABLE LABELS

- A. Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

2.12 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 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. A unique outer jacket color and jack color shall be installed to identify the system type the cable is associated. Coordinate the cable outer jacket and jack color scheme with Owner during shop drawing review.
- B. 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).
- C. Install all cables only when the temperature is between 32°F to 122°F.
- D. Wiring Method: Wiring shall be installed in EMT conduit within walls and above inaccessible ceilings. Wiring installed above accessible ceilings between ceiling mounted devices or conduit stub-ups 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.
- E. Test each cable as detailed in specification. Include patch cord in test channel.
- F. Identify all cables with a neatly typed label as detailed in specification.
- G. Provide horizontal and vertical cable management in all racks, on all backboards and any other location cabling is not routed in conduit. Size cable management for 50% additional cables.
- H. 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.
- I. Install cable without damaging conductors, shield or jacket, do not use unjacketed pairs for jumpers.

- J. Do not bend cable in handling or in installing to smaller radii than minimums recommended by manufacturer.
- K. 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.
- L. Provide at least 10' of cable slack at MDF or IDF closet. This slack may be stored in a cable management device behind the MDF/IDF.
- M. Provide 2' diameter in service loops or use figure-8 or serpentine.
- N. 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.
- O. Remove jacket of cable and untwist individual UTP conductors the minimum amounts required to terminate on jacks and patch panels.
- P. Category 6A cable fill in conduit is 40% maximum as follows:
 - 1. 1" – up to 6 UTP Cables
 - 2. 1-1/4" - 10 UTP Cables
 - 3. 1-1/2" - 13 UTP Cables
 - 4. 2" - 22 UTP Cables
 - 5. 2-1/2" - 31 UTP Cables
 - 6. 3" - 49 UTP Cables
 - 7. 3-1/2" - Not recommended
 - 8. 4" - Not recommended
 - 9. Provide larger conduits than recommended for cable fill if indicated on the Drawings.
- Q. 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.
- R. 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.
- S. 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.
- T. 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.

- U. 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.
- 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 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 cabling system premises network which meets the channel performance as described in ANSI/TIA/EIA-568-C.2.

END OF SECTION 271501

SECTION 274132 –TELEVISION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all equipment associated with the television distribution in the school. This work shall include television electronics and cabling as required to provide a system for the distribution of signals.
- B. Contractor shall coordinate with the Owner's local cable utility company as required.
- C. Owner will pay any fees with the local cable utility company for cable television service to the building.

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 equipment to be provided and installed.
 - c. Data sheets of all items to be provided with specific item or model number highlighted.
 - d. Proposed block diagram showing locations and arrangement of signal processing equipment in a flow diagram format.
- C. System layout drawings shall be provided after equipment is approved showing calculated tap values and drop lengths for each outlet location in the building.

1.3 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of equipment installed.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum 3 years documented experience and with service facilities within 100 miles of project.
- B. Installer: Company specializing in installing the products specified in this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to project site in original factory wrappings and containers, clearly labeled with identification of manufacturer. Inspect equipment to ensure that no damage has occurred during shipment. Do not install damaged equipment; remove from site and replace damaged equipment with new.
- B. Store materials in original packages and containers, inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity; laid flat, blocked off ground to prevent sagging and warping. Protect products from weather, damaging fumes, construction debris and traffic.
- C. Handle wire and cable carefully to avoid abrading, puncturing, and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance and characteristic impedance integrity of transmission media are maintained.
- D. Comply with instructions and recommendations of manufacturer for special delivery, storage, and handling requirements.
- E. Bring to the job site only the quantities of materials which can be installed in one days' time. The Owner will not provide on-site storage areas for the Contractor.

1.6 COORDINATION

- A. Before selecting values of feed-through line taps, verify signal strength at input of system.
- B. Coordinate system signal values, outlet quantities, and cable lengths between tapoffs with the local cable company.
- C. Obtain line tap values from cable company's calculated signal drops before installing taps.

1.7 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 TELEVISION NETWORK

- A. The system shall receive cable television signals, amplify these signals by a broadband amplifiers as required for proper signal levels, and distribute these signals to all TV outlets to permit the connection of standard cable ready television receivers commonly manufactured for the standard frequency bands. The system shall be capable of the distribution of locally originated television program material on a locally originated television channel via appropriate modulators and channel elimination filters. The system shall be designed with a minimum bandwidth of 5-750MHz.

- B. The system, as installed, shall be capable of passing standard NTSC color television signals without the introduction of noticeable effects on the color fidelity or intelligence.
- C. The system shall provide a typical signal level of 5 DbMV across 75 ohms, per channel at each television outlet. In no case shall the signal level be greater than +10 DbMV or less than 0 DbMV. Where system input is greater than 50 millivolts on any one channel, the signal level on all channels at each television outlet shall be not less than 3 millivolts.
- D. The system and all equipment shall be designed and rated for 24 hours per day continuous operation.
- E. The system noise figure shall not be more than 15 dB. The distribution design shall be such that no more than 2 amplifiers shall be in any distribution path from incoming cable to last outlet in the furthest trunk.
- F. The system shall use equipment matched to 75 ohms impedance with maximum voltage standing wave ratio VSWR of 1.4 to prevent ghosts or smear.
- G. The phasing characteristics of the system shall not cause ghosts or double images to appear in receivers used with the system.

2.2 TELEVISION CABLES

- A. Manufacturers:
 - 1. Belden
 - 2. West Penn
 - 3. Commscope
 - 4. Berk-Tek, Inc.
- B. Each reel of coaxial cable used in the system shall be sweep tested for transmission and structural return loss and be so certified in writing by the cable manufacturer. Transmission sweep tests shall establish conformance to guaranteed loss values from 5-750 MHz. Structural return loss tests by sweep method shall show a minimum return loss of 26 dB RL VHF.
- C. There shall be no splicing of coaxial cables between terminating points. All conduit entrances shall be suitably protected with weatherheads.
- D. All coaxial cable between the main amplifier and the isolation tapoff units shall be Type 625 hard line minimum. RG6 quadfoil shield minimum may be used for room dropoffs. 625 sizes shall be used where required for proper system performance.
- E. All coaxial cable shall be plenum rated.

2.3 TELEVISION ELECTRONICS

- A. The naming of manufacturers or items of material is not intended to be restrictive, but rather to establish criteria for design and quality. Catalog and model numbers are intended to indicate type, quality of design and material, as well as exact operating features required.

- B. Provide at least the following major items of equipment and all additional equipment for a complete and operating system. AR - quantity as required
 - 1. (AR) – Blonder Tongue BIDA 100A-30 Broadband Indoor Distribution Amplifier(s) as required for proper performance. Provide a minimum of 1 for the Telecommunications Closet.
 - 2. (AR) – Blonder Tongue SXRS Series Splitters for response to 750 MHz or equal.
 - 3. (AR) – Blonder Tongue SRT Series Multitaps for response to 750 MHz or equal.
 - 4. (AR) – “F” type outlets to match structured cabling devices.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with installation instructions provided by system manufacturer.
- B. Provide wiring as required for the system.
- C. Wiring Methods:
 - 1. 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.
 - 2. 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.
 - 3. Route all system wiring from the intercommunications and program systems rack 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 cabling in all open structure spaces.
- D. Cable identification shall be provided on both ends of each cable and termination with the Owners room number and the wiring block or device to which it is connected. Tags shall be permanent and neat.
- E. Provide necessary conduit, raceways, pull boxes, outlet boxes and wire to provide a complete and operational system.
- F. All wiring shall be tested for continuity and freedom of all grounds and short circuits.
- G. Install CATV cable to insure minimum allowable signal level at all outlets.
- H. Provide bushings on the cable tray end of all conduits to prevent cable damage.
- I. Mount like tap-offs on cable tray or in network racks as required to service 4-8 drops per tap-off.
- J. Provide 3/4" plywood in all telecommunications closets to install television electronics.

- K. Provide one surge suppressor quad receptacle and wiring at each amplifier connected to spare 1P.20A circuit breaker in closets panel.

3.2 DEMONSTRATION

- A. Perform demonstration at final system inspection by qualified representative of manufacturer.
- B. Conduct walking tour of project and briefly describe function, operation, and maintenance of each component.

END OF SECTION 274132

SECTION 275133 – INTEGRATED ELECTRONIC COMMUNICATIONS NETWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. The contractor shall furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating VoIP school communications system. This specification is based on the Bogen Nyquist E7000 school communications platform which is considered the Haverford School District standard.

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code
- B. ANSI/NEMA SB-40 – Emergency Communications Systems for Life Safety in Schools.
- C. UL 60950 – Information Technology Equipment - Safety

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 in the system.
 - c. Data sheets of all items to be provided with specific item or model number highlighted.
 - d. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation, and maintenance. Include a single-line diagram showing cabling interconnection of components and levels throughout system and impedances. Delineate contractor furnished and owner furnished network equipment.
 - e. Each drawing shall have a descriptive title and all sub-parts of each drawing shall be labeled. All drawings shall have the name and locations of the project, Systems Contractor's name in the title block. Provide drawings showing all equipment required by these specifications for this project.
 - f. Details and descriptions of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.
- C. FCC Approval: The system shall be approved for direct interconnection to the telephone utility under Part 68 of FCC rules and regulations. Provide the FCC registration number of the system being proposed as part of the submittal process.

- D. Product Certificates: Signed by manufacturers of equipment certifying that products furnished comply with specified requirements.
- E. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.
- F. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.
- G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.
- H. Maintenance Data: For equipment to be included in maintenance manuals specified in Division 1.
 - 1. Record of Owners equipment-programming option decisions.
 - 2. All instructions necessary for proper operation and manufacturer's instructions.
 - 3. "Proof of Performance" information.
 - 4. Manufacturer's maintenance information.
 - 5. Copies of non-proprietary computer programs and system set up disks documenting all programmable features of the installed system.
- I. System Training: Submit the following information describing the training programs and system trainers as outlined in paragraph 1.6 of this specification and in accordance with Division 1 specifications.
 - 1. Include with the submittal a preliminary staff development training program in outline form for review and approval by the owner's representative.
 - 2. Include with the submittal a current copy of the trainer's certification from the manufacturer that certifies and identifies the trainer(s) who are eligible to provide training and support for the project.
 - 3. Include with the submittal a current copy of trainer's need's assessment form which will be reviewed with the Owner's designated representative for the system's preliminary system programming and configuration.
 - 4. Include with the submittal copies of all documentation used to identify for the owner those participants attending and completing the training programs.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Drawings of the completed system reflecting any changes that were made from the original submission of drawings.
- C. A letter from the installing sub-contractor stating that all equipment provided is covered by the required warranty.
- D. Training Completion sign in form.

1.5 QUALITY ASSURANCE

- 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. Installer Qualifications: An experienced installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section. The installer's main service location must be less than a 2-hour drive time from the project site (according to google maps). Provide the following with in thirty (30) days after notification to proceed:
 - 1. Provide a list of installations of systems meeting the specifications herein that the Installer has specifically installed for verification by the Owner. Provide contact name, phone number and email address for all installation sites. Random installations from other vendors and/or Installers shall not be accepted. The Installer, not its employees, must meet these qualifications.
 - 2. The Installer shall demonstrate to the satisfaction of the Owner or his representative that he has:
 - a. Adequate plant and equipment to pursue the work properly and expeditiously.
 - b. Adequate staff and technical experience to implement the work.
 - c. Suitable financial status to meet the obligations of the work.
 - d. Technically capable and factory trained service personnel at a local service facility to provide routine and emergency service for all products used in this project.
 - 3. Installer shall have on his fulltime staff for installation, maintenance, and client support a Microsoft Certified Database Administrator (MCDBA) and a Microsoft Certified Technical Specialist (MCTS).
 - 4. Submittal shall include copies of reference site contacts and manufacturer and staff technical certifications.
- D. Any Contractor, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of an "Installer" who does meet the requirements and who shall provide the equipment, make all connections, and continuously supervise the installation. A subcontractor so employed as the "Installer" must be acceptable to the Architect/ Engineer. The "Installer" shall be identified within thirty (30) days of notification to proceed for acceptance by the Architect/Engineer
- E. Because the life expectancy of this type of communications structure normally exceeds 10 years, the owner expects continuity from the service provider. The installing/servicing company shall be an authorized provider of the manufacturer's product or similar product for at least 15 years.
- F. Each major component of equipment shall have the manufacturer's name and model number, NEMA code ratings, UL Label, and other data factory printed on the surface of the equipment and easily visible.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.6 IN-SERVICE TRAINING

- A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.
- B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.
- C. All staff development training is to be coordinated through the Owner's designated representative. As training sessions are completed, the trainer will provide the school's administrative staff and school district's staff a document listing all the staff and faculty members who attended, received, and completed the training program.

1.7 SINGLE SOURCE RESPONSIBILITY

- A. Except where specifically noted otherwise, all equipment supplied shall be the standard product of a single manufacturer of known reputation and a minimum of 30 years of experience in the industry. The supplying contractor shall have attended the manufacturer's installation and service training classes. A certificate of this training shall be provided with the contractor's submittal.

1.8 PROTECTION

- A. The contractor shall provide all necessary transient protection on the AC power feed and on all station lines leaving or entering the building.
- B. The contractor shall note on their system drawings, the type and location of these protection devices and all wiring information. Such devices are not to be installed above the ceiling.

1.9 WARRANTY

- A. Provide a manufacturer's five-year warranty of the school communications network equipment against defects in material and workmanship. This warranty will cover all central electronic equipment as well as peripheral devices such as speakers, horns, microphones, and administrative telephones. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one-year warranty shall be provided for labor.
- B. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's letterhead. The standard five-year warranty is an important element in establishing a standard in quality. Manufacturers who circumvent the five-year warranty by offering special "extended warranties" that are not part of their normal published warranty will not be accepted.

- C. The manufacturer's warranty shall include software updates including full version software releases and service patches for the full five years.
- D. Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hours of service visit, the contractor shall provide "loaner" equipment to the facility at no charge.
- E. Make available a service contract offering continuing factory authorized service of the system after the initial warranty period.
- F. Provide the warranty specified in Section 260010.

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. NQ-E7030 Analog Station Bridge: Qty 1
 - 2. Ceiling and Wall-Mounted Speakers: Qty 2 of each type and rating installed.
 - 3. Horn Speaker: Qty 1 of each type and rating installed.
 - 4. Volume Control: Furnish 1 of each type and rating installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Bogen Nyquist E7000MCR System manufactured by Bogen Communications LLC
 - 1. District Standard Product. No Substitutions.
- B. Authorized Bogen Distributor contact:
 Intellicom Systems Inc.
 7112 Airport Highway
 Pennsauken, New Jersey 08109
 Contact: Mike Ramano
 Phone: 856-665-5366 Ext. 320
 Email: romanom@intellicomsys.com

2.2 EQUIPMENT

- A. Provide the Nyquist NQ-E7000MCR Factory Assembled Rack Assembly consisting of:
 - 1. 42" Rack with Locking Rear Door, Locking PC Drawer, and Caster Kit
 - 2. 1500VA UPS with Surge Protection
 - 3. NQ-SYSCTRL Nyquist System Controller
 - 4. Nyquist Software and Licensing Package
 - 5. Mini Laptop Administration PC
 - 6. NQ-E7010 Input/Output Controller
 - 7. NQ-P0100 Matrix Mixer/Preamplifier
 - 8. NQ-16P-POE+ 16-Port POE Switch

9. NQ-E7030 24-Port Analog Station Module(s)
10. NQ-A4060-G2 4-Channel 60-Watt Power Amplifier
11. NQ-TEL-SIP District Telephone System Interface Software

B. Provide the following Nyquist Peripheral Equipment:

1. NQ-T1100 VoIP Color Touchscreen Phone (Main Office)
2. NQ-T2000 VoIP LCD Phone (Principal's Office)
3. DDU250/NQ-GA10P Emergency Paging Microphone
4. CSD2X2U-V2 2x2 Ceiling Tile Speaker
5. S86T725PG8U Recessed Ceiling Speaker
6. AT10A Single-Gang Volume Control
7. MB8TSL Surface Wall Speaker
8. MB8TSQ Surface Ceiling Speaker
9. SPT15A Surface Interior Horn Speaker
10. SGHD8/FMH15T/BBSM6 Surface Vandal-Resistant Exterior Horn Speaker

2.3 SYSTEM WIRING

A. Manufacturers

1. Commscope
2. Belden
3. West Penn

B. Wiring type and gauge shall be as recommended by the system manufacturer.

C. All wiring shall be plenum rated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the School Communications and School Safety Network.

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

3.2 INSTALLER/CONTRACTOR REQUIREMENTS

A. All final headend, programming, and certification work shall be performed by a documented manufacturer's authorized representative.

B. As further qualification for bidding and participating in the work under this specification, the system installer shall hold a valid C-10 Contractor's License issued by the Contractor's State License Board. The manufacturer's representative shall have completed at least 10 projects of equal scope, giving satisfactory performance, and shall have been in the business of furnishing and installing sound systems of this type for at least five years. The manufacturer's

representative shall be capable of being bonded to ensure the owner of performance and satisfactory service during the guarantee period.

- C. The manufacturer's representative shall provide a letter with submittals from the manufacturer of all major equipment stating that the manufacturer's representative is an authorized distributor. This letter shall also state that the manufacturer guarantees service performance for the life of the equipment and that there will always be an authorized distributor assigned to service the area in which the system has been installed.
- D. The contractor shall furnish a letter from the manufacturer of the equipment. This letter shall certify that the equipment has been installed according to factory intended practices, that all the components used in the system are compatible, and that all new portions of the systems are operating satisfactorily. Further, the contractor shall furnish a written unconditional guarantee for all parts and all labor for a period of five years after final acceptance of the project by the owner.

3.3 INSTALLATION

- A. Comply with installation instructions provided by system manufacturer.
- B. Provide wiring as required for a properly operating system.
- C. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching transformers where required.
- D. Control Circuit Wiring:
 - 1. Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
 - 2. Connect field cable to each Analog Speaker transformer using UL butt splices for #22 AWG wire. Any unused transformer leads shall be individually safed-off/insulated.
- E. Category 6A installation shall meet the requirements of Division 27.
- F. Wiring Methods:
 - 1. 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.
 - 2. 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.
 - 3. Route all system wiring from the 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 cabling in all open structure spaces.

- G. Cable identification shall be provided on both ends of each cable and termination with the Owners room number and the wiring block or device to which it is connected. Tags shall be permanent and neat.
- H. Provide necessary conduit, raceways, pull boxes, outlet boxes and wire to provide a complete and operational system.
- I. All wiring shall be tested for continuity and freedom of all grounds and short circuits.
- J. Each cable run between the console and remote locations shall be one continuous cable. System cable shall not share conduit with any other system.
- K. Paint exterior speaker baffles in color selected by Architect.
- L. The contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.
- M. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.
- N. Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12" minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.
- O. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams. Each cable identification shall have a unique number located approximately 1-1/2" from cable connection at both ends of cable. Numbers shall be approximately 1/4" in height. These unique numbers shall appear on the As-Built Drawings.
- P. Mark and label all demarks IDF and MDF points with destination point numbers. Rooms with more than one outlet shall be marked XXX-1, XXX-2, XXX-3, etc. where XXX is the room number.
- Q. No graphic room number shall exceed the sequence from 000001 through 899999.
 - 1. All outside speakers shall be on a separate Page Zone and Time Zone.
 - 2. All zones shall be laid out not to exceed 40 Watts (@25V) maximum per zone.
 - 3. All hallway speakers shall be tapped at 1 Watt (@25V) maximum.
 - 4. All outside horns shall be tapped at 3.75 Watts (@25V) maximum.
 - 5. All classroom speakers shall be tapped at ½ Watt (@25V) maximum.
 - 6. Large rooms, such as cafeterias, shall be tapped at 2 Watts (@25V) maximum.
 - 7. District shall be provided with proposed zoning and station numbering lists before implementation into the system.
- R. Plug disconnect: All major equipment components shall be fully pluggable by means of multi-pin receptacles and matching plugs to provide for ease of maintenance and service.

- S. Protection of cables: Cables within terminal cabinets, equipment racks, etc., shall be grouped and bundled (harnessed) as to type and laced with No. 12 cord waxed linen lacing twine or T and B wire-ties, or hook and loop cable management. Edge protection material shall be installed on edges of holes, lips of ducts, or any other point where cables or harnesses cross a metallic edge.
- T. Shielding: Cable shielding shall be capable of being connected to common ground at point of lowest audio level and shall be free from ground at any other point. Cable shields shall be terminated in the same manner as conductors.
- U. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.
- V. Call Switches (when applicable) and Volume Controls shall be wall-mounted:
 - 1. Mount at 54" AFF.
 - 2. All wiring should be concealed.
 - 3. Verify exact location with architect.
 - 4. Avoid mounting near doors to prevent students from activating and running out of the rooms.
- W. Administrative telephones shall be desk or wall mounted and have associated adjacent modular jack.

3.4 GROUNDING

- A. Provide equipment grounding connections for Integrated Electronic Communications Network systems as required by manufacturer. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
- B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.
- C. Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring information.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
- B. Inspection: Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.

- C. Testing: Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.6 FINAL ACCEPTANCE TESTING

- A. The Final Acceptance Testing shall be provided to the Owner or the Owners designated representative only. Final acceptance testing to any other trade or service provider for the project will not comply with the requirements of this section.
- B. The contractor will provide a Final Acceptance Test record document signed by both the contractor and the Owner or designated Owner's Representative establishing the "In Warranty" date. The warranty period will not commence until the Final Acceptance Test is completed.
- C. Contractor shall be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.
- D. Controller shall coordinate with District IT personnel for the SIP interface to the District telephone system.
- E. Verify the following prior to actual tests and adjustments to the systems:
 - 1. Electronic devices are properly grounded.
 - 2. Powered devices have AC power from the proper circuit and hot, neutral, and ground conductors are connected properly.
 - 3. Insulation and shrink tubing are present at each cable terminated on a terminal strip or connector without a shell.
 - 4. Dust, debris, solder splatter, etc. are removed.
 - 5. Cables are dressed, routed, and labeled correctly.
 - 6. Connections are consistent with regard to polarity.
- F. Audio System Tests: Measure and record the impedance of each loudspeaker terminating at the amplifier. An impedance meter must be used. A DC resistance meter will not be accepted. Record each speaker impedance measurement and provide to owner in "as-built" drawings.

3.7 OWNER TRAINING

- A. Contractor shall provide a minimum of eight hours of configuration and operational instruction to school personnel.
 - 1. Bogen Communications LLC, shall provide online "How To" videos for instructing the teaching staff on how to operate the Teacher Dashboard aspect of the system.
- B. Schedule training with Owner through the Owner's representative, with at least seven days advance notice.

- C. On the first school day following installation of the Nyquist System, the contractor shall provide a technician to stand by and assist in system operation.

END OF SECTION 275133

SECTION 275313 – CLOCK SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all equipment associated with the installation of the Clock System. This work shall include a master clock system, secondary clocks and wiring as required for a complete and operating system.

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 equipment to be provided and installed in the system.
 - c. Data sheets of all items to be provided with specific item or model number highlighted.
 - d. Basic riser diagram to include all equipment and all wiring required.

1.3 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of master clock system and secondary clocks.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum 3 years documented experience and with service facilities within 100 miles of project.
- B. Installer: Company specializing in installing the products specified in this section with minimum three years documented experience.

1.5 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. Clocks: Furnish 1 of each type and rating installed.

1.6 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MASTER CLOCK SYSTEM

- A. The central control console shall include a Master Clock Control System. It shall be microprocessor-based and user-programmable through its electronic keypad. The unit will permit programming, diagnostics, and activity logging through connection to the Administrative Computer. The unit will be fully interfaced to the Integrated Network Electronic Communication system listed in Section 275133. Provide all necessary ancillary equipment for the complete system operation.
- B. The system shall provide the following functions:
 - 1. Capacity for storing 800 events and up to 100 holidays in non-volatile memory.
 - 2. Ability to review, edit and delete events.
 - 3. Review of events from any entered time of day.
 - 4. Events shall be programmable to any one or all zone circuits.
 - 5. Selection of any one of twenty-four (24) schedules to allow flexibility due to seasonal changes or special events.
 - 6. Fully automatic holiday program execution. Bells can be silenced, or special schedules can be implemented. Normal bells will resume after the holiday period.
 - 7. User-programmable Automatic Daylight Savings Time Change.
 - 8. Programmable Music-on-Class-Change, this feature shall be programmable from 1 to 15 minutes.
 - 9. Separate bell duration for each zone circuit.
 - 10. Latched operation of zones to control lighting or other devices.
 - 11. Ability to test all output zone circuits.
 - 12. Accumulation of down time during power outage to reset slave clocks, both minute-impulse and synchronous types after the power has been restored.
 - 13. User-programmable custom slave clock correction.
 - 14. Output relays rated at 5 amperes shall be provided on all four (4) zone circuits.
 - 15. Crystal-controlled time-base for assured accuracy.
 - 16. Lithium battery will provide not less than 5 years battery back-up for timekeeping function.
- C. Provide Sapling model SMA-3R0-1004-1 master clock with wireless clock signal transmitter.
- D. Provide Sapling model SMA-1SM-0000-1 network repeater(s) for the building as required.

2.2 WIRELESS ANALOG SECONDARY CLOCKS

- A. The following equipment shall be furnished and installed in all locations and quantities as shown on the plans:
 - 1. 12" Secondary Clocks shall be Sapling Model SAL-4BS-12R-14 wireless analog, 120V powered.
 - 2. 16" Secondary Clocks shall be Sapling Model SAL-4BS-16R-14 wireless analog, 120V powered.
 - 3. All clocks shall be 12" unless 16" is indicated on the plans.
 - 4. Provide double mount housings Sapling Model SAH-1BD-12R-0 for two 12" secondary clocks wherever bi-directional clocks are shown on the plans.

5. Provide wireguards for gymnasiums or where shown on the plans.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with installation instructions provided by system manufacturer.
- B. Provide 1P.20A breaker in nearest 120/208V panelboard and connect to receptacle for the master clock system with 2#10 + 1#10 ground in 3/4" conduit unless otherwise noted.
- C. Provide wiring as required for the system.
- D. Wiring Methods:
 1. 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.
 2. 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.
 3. Route all system wiring from 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 cabling in all open structure spaces.
- E. Provide 2#12 + 1#12 ground in 3/4" conduit from secondary 120V clock to nearest 120V receptacle circuit unless otherwise noted.

3.2 DEMONSTRATION

- A. Perform demonstration at final system inspection by qualified representative of manufacturer.
- B. Conduct walking tour of project and briefly describe function, operation, and maintenance of each component.

3.3 TRAINING

- A. Personnel Training: Provide and pay for the services of a factory-authorized service representative to demonstrate the system and train Owner's personnel.
 1. Provide training for operating, testing, troubleshooting and general maintenance of the system.
 2. Provide a 1-hour session to demonstrate the system.
 3. Provide documentation of sessions to Architect/Engineer with signatures of at least 3 Owners Representatives present at demonstration.

END OF SECTION 275313

SECTION 275319 – DISTRIBUTED ANTENNA SYSTEM (DAS)

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. The system shall consist of an FCC Part 20 approved fiber-based signal booster system to enhance cellular coverages for ALL carriers throughout the school. The system shall improve cellular reception and signal strength inside the school building, ensuring reliable connectivity for staff, students, and emergency services. The system shall have a retransmit agreement for all Carriers. The system shall include complete installation, testing and commissioning of the system.
- B. Upon commissioning, the distributed antenna system (DAS) shall provide coverage for the Wireless Service Providers (WSP) listed below on all frequencies currently being used by the designated WSP:
 - 1. AT&T Wireless
 - 2. Sprint/Nextel
 - 3. T-Mobile
 - 4. Verizon
- C. The contractor's scope of work shall include the following:
 - 1. Perform site survey and assessment of signal conditions.
 - 2. Procurement and installation of an FCC Part 20 Approved Fiber Signal Booster system.
 - 3. Providing fiber and coaxial cables to necessary locations.
 - 4. Installation of donor and indoor antennas for optimal coverage.
 - 5. System integration and testing.
 - 6. Post-installation support and training for facility staff.
- D. Any permits necessary for the installation of the work shall be obtained prior to the commencement of the work. All permit costs and inspection fees shall be included in Base Bid.

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. System Installation company name, address, and contract details along with relevant experience in installing signal booster systems.
 - 2. 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. Coaxial and Fiber Cable
- 3. 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 system device locations shown.
 - d. Typical device connections for each type of device used in the system.
 - e. Basic riser diagram to include control equipment and all field circuits.
- 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 installation contractor.

1.3 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. Operating and Instruction Manuals of the entire system.
- E. Copy of the Testing and Maintenance Agreement for the first year of service.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with a minimum of three years documented experience.

1.5 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS AND OPERATIONS

2.1 MANUFACTURER

- A. Basis of Design: SureCall SignalMax Fiber DAS

2.2 TECHNICAL SPECIFICATIONS AND PERFORMANCE REQUIREMENTS

- A. Uplink Frequency Range (MHz): 698-716 / 776-787 / 824-849 / 85-1915 / 1710-1755
- B. Downlink Frequency Range (MHz): 728-746 / 746-757 / 869-894 / 1930-195 / 2110-2155
- C. Donor/Service Port Impedance: 50 ohms
- D. Maximum Gain 64dB (<1Ghz), 72dB (>1GHz)
- E. Noise Figure: <8 dB
- F. Supported Standards: 5G / 4G / LTE cellular standards
- G. Maximum Uplink Power: 30 dBm EIRP
- H. Maximum Downlink Power: 17 dBm EIRP
- I. Fiber/Cable: Single mode optical cable – System supports SMF optical fiber lengths up to several kilometers.
- J. Master Unit (Model SC-FMU)
 - 1. Dimensions: 5.5 x 9.3 x 13.4 inches
 - 2. RF/Optic Connectors: 1 N-Female / 4 SC UPC Female
 - 3. Operation Temperature: -22°F to +158°F
 - 4. Power Consumption: <30W
 - 5. AC Input: 48VDC
 - 6. FCC Certifications: Part 15, Part 20, Part 22, Part 24, Part 27
 - 7. Case Rating: IP66
 - 8. User Interface (Carrier Selection): BLE & IoT (with SMA antenna) / GPS (with SMA antenna)
- K. Remote Unit (Model SC-FRU)
 - 1. Dimensions: 5.5 x 9.3 x 13.4 inches
 - 2. RF/Optic Connectors: 4-N-Female / 1 SC UPC Female
 - 3. Operation Temperature: +23°F to +135°F
 - 4. Power Consumption: <40W
 - 5. DC Input: 24 VDC
 - 6. FCC Certifications: Part 15, Part 20, Part 22, Part 24, Part 27
 - 7. User Interface (Carrier Selection): BLE (with SMA antenna)
- L. Ultra-wideband Outdoor Directional Yagi Antenna (Model SC-530W)
 - 1. Dimensions: 17.3 x 8 x 1.45 inches
 - 2. Connectors: N-Female 50 ohm
 - 3. Antenna Gain: 7 / 8/ 9 dBi maximum
 - 4. VSWE: ≤2.0
 - 5. Polarization Type: Vertical
 - 6. Signal Pattern: Directional
 - 7. Maximum Power: 50 watts

8. Beamwidth: H:90° E:60° / H:90° E:60° / H:70° E:55°
9. Color: White
10. Operating Temperature: -22°F to +140°F
11. Ultra-wideband: 2G, 3G, 4G and 5G (617 – 2700 MHz)
12. Include mounting hardware and supports.

M. C-Band MIMO Indoor Ultra-thin Antenna (Model SC-628CBM)

1. Dimensions: 12.2 inches diameter x 2.11 inches high
2. Antenna Type: Indoor MIMO
3. Frequency: 617-698 / 698–960 / 1710-2700 / 3700-4000 MHz
4. Beamwidth: H:360° E:70° / H:360° E:55° / H:360° E:45°
5. Input Impedance: 50 ohm
6. Antenna Gain: 4 / 5 dBi
7. VSWR: <2.0
8. Polarization Type: Vertical
9. Signal Pattern: Omni-directional
10. Maximum Power: 50 watts
11. Connector: N-Female
12. Color: White
13. Mounting Type: Ceiling
14. Housing: PC+ABS
15. Operating Humidity: 5% - 95%
16. Operating Temperature: -22°F to +140°F

2.3 RF COAXIAL CABLE

- A. RF Coaxial Cable shall be a listed CMP plenum or armored plenum coaxial cable or 2-hour fire rated plenum coaxial cable. Non-plenum cable can be used when installed in a metallic raceway. The cable classification shall be clearly marked on the outer surface of the cable regular intervals.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation of all components of the In-building distributed antenna system.
- B. All installed systems will need prior written approval from the FCC license holder of the systems being re-amplified and must meet their established criteria for installation prior to the system installation.
- C. Installed systems shall be registered with the FCC signal booster registry where required.
- D. Provide circuit breaker lockout for all circuit breakers feeding distributed antenna system.

3.2 FIELD QUALITY CONTROL

- A. Acceptance testing for the distributed antenna system is required upon completion of installation.
- B. All tests shall be conducted, documented, and signed by a factory-authorized service representative.
- C. All test records along with system diagrams, iBwave design, equipment specifications, user manuals, RF link budget calculations and other design data shall be submitted upon completion of the project to the owner.

3.3 TRAINING

- A. Personnel Training: Provide and pay for the services of a factory-authorized service representative to demonstrate the system and train Owner's 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 the demonstration.

END OF SECTION 275319

SECTION 277000 – LOCAL AUDIO/VISUAL REINFORCEMENT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all equipment associated with the installation of a local audio/visual reinforcement system for the rooms indicated. This work shall include a rack, mixer, digital signal processor, amplifiers, loudspeakers, audio/video player, video presentation equipment, projector with mount, assistive listening systems, microphones, microphone receptacles and wiring, etc. as required for a complete and operating system. All equipment and installation material required shall be furnished whether enumerated herein or not.
- B. Scope of Work:
 - 1. Gymnasium C124/Platform C126
 - 2. Cafeteria B123
 - 3. Music C122
 - 4. Instrumental C113
 - 5. Instrumental C129

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 equipment to be provided and installed in the system.
 - c. Data sheets of all items to be provided with specific item or model number highlighted.
 - d. Basic riser diagram for each system to include all equipment and all wiring required.
 - 2. Drawings: Prior to fabrication submit contractor-generated drawings for approval for all supplied systems:
 - a. These drawings shall include, but are not limited to, the following:
 - 1) Title Sheet with sheet index and symbols legend.
 - 2) All panels, plates, and designation strips, including connectivity, layout, labeling, and details relating to terminology, engraving, finish and color.
 - 3) All equipment racks, cabinets, consoles, tables, carts, support bases, and shelves.
 - 4) Schematic drawings (AV & Control Signal Flows), system functional block drawings, including those for audio and video subsystems.
 - 5) All unusual equipment modifications.
 - 6) Equipment rack elevations.
 - 7) Equipment location drawings.
 - 8) Dimensions for all AV equipment racks and enclosures, verifying adequate space, power, and ventilation are provided.

- 9) Cable labeling plan
- 10) Floor Plans, RCPs and Elevations:
 - a) Show planned location for all elements and cable routing.
 - b) Indicate projector distance, throw ratio, and lens.
 - c) For any inductive loop assisted listening systems, indicate the inductive loop pathway.
- 11) Drawings should be at project standard scale and clearly legible.
- 12) Resubmission of contract drawings does not constitute a complete shop drawings submittal and is unacceptable. Such submittals will be rejected.

1.3 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of equipment provided.

1.4 QUALIFICATIONS

- A. Manufacturer: Equipment manufactured by those as listed shall be considered as meeting these specifications. The naming of the manufacturer or item of material is not intended to be restrictive, but rather to establish criteria for design and quality. Catalog and model numbers are intended to indicate type, quality of design, material, as well as exact operating features required.
- B. Other manufactures shall be considered for use if submitted for approval 10 days before the published bid date. The alternate system submission shall include all inter-panel block wiring diagrams for systems where product substitution is requested. Any prior approval of an alternate system does not automatically exempt the alternate supplier from meeting the intent of these specifications. Final approval of the alternate system shall be determined at the time of job completion. Failure to provide the "precise functional equivalent" shall result in the removal of the system at the contractor's expense. The submittal shall include published literature which clearly indicates specific compliance of products with requirements of this specification.
- C. Supplier/Installer: The supplier must have a minimum of five years experience in the design and installation of systems equal in size and type required by this project. The supplier must maintain a local service organization within a one hundred (100) mile radius of the installation with spare service replacement boards, components, and accessories.
- D. The supplier/installer must be the authorized representative of the equipment manufacturer supplied and have full-time technicians trained and certified in the installation and service of the equipment supplied.

1.5 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCT

2.1 GYMNASIUM C124 / PLATFORM C126

A. Sound Reinforcement System

1. The Multi-Purpose shall be provided with a complete locally controllable sound system including assembly and performance mode operation, digital equalization, feedback filtering, CD Player, Wireless microphones, and specifications as follows. The system shall be combined with all equipment in one rack allowing simultaneous independent operation of each space.
2. Note: All Equipment shall conform to the manufacturer's latest published specifications in feature and function both physically and electrically whether or not those specifications are delineated herein. The manufacturer's latest published specifications shall be considered as part of this text. Equipment shall be Allen & Heath, Audio-Technica, Ashley, Biamp, BSS, Crown, DBX, Denon, EAW, Electro-Voice, JBL, Sabine, Shure, Soundcraft, Symetrix, Tascam, Telex, or Yamaha.
3. The Assembly Mode Mixer/Digital Signal Processor shall be provided with twelve inputs. The processor shall be fed by wired microphone inputs, the CD changer, two wireless microphones, and the performance mode console/line input. The Digital Signal Processor Controller shall provide Gain Management/Limiter/ Equalizer/Delay/Mix Matrix functions for loudspeakers with inputs and outputs as listed. The processor shall have programmable capability enhanced by full complement of audio devices available from a Win32 based Graphical User Interface (GUI). Audio processing devices available are, but not limited to: automatic mixers, crossovers, AGC, gates, limiters, expanders, duckers, delay lines, meters, mixers, routers, test signal sources, room and ring mode equalizers, and automatic "dynamic search and delete" feedback filters. The system shall have 24-bit A/D and D/A converters and RS-232/485 connection for remote serial control functions. The digital signal processor shall have a frequency response of ± 0.5 dB or better from 20 Hz to 20 kHz. Its total harmonic distortion shall be no more than 0.01% from 20 Hz to 20 kHz with a +4 dBu input signal and a +4 dBu output signal, both with 20 dB of headroom. It shall have a dynamic range of not less than 103 dB A-weighted. Input common mode rejection ratio (CMRR) shall be greater than 55 dB at any gain setting. The maximum input level without clipping shall be +30 dBu while maintaining the specified CMRR. The maximum output level shall be +24 dBu while still meeting the frequency response specification. The balanced input impedance shall be 6k ohm or higher. The balanced output impedance shall be 102 ohms and designed to drive 600 ohm loads or greater while maintaining the specified frequency response. Provide system with outputs for Multi-Purpose Room loudspeakers and assisted listening system. System shall be Ashly AQM-1208.
4. Power amplifiers shall be multi-speed fan cooled to reduce cleaning requirements. Provide Crown CDi 2/600 and CDi 2/1200 amplifiers with integral DSP or equal by Electro-Voice, or QSC. Provide two (2) 1200 watt channels, each into 4 ohms for the left Column loudspeakers. Provide two (2) 1200 watt channels, each into 4 ohms for the right Column loudspeakers. Provide two (2) 600 watt channels, each into 4 ohms for the Stage Monitor loudspeakers.
5. The local multi-format audio player shall be Tascam Model CD-400U – CD player with ¼" auxiliary input, Bluetooth and USB with rackmount located in the equipment rack.
 - a. Provide one (1) audio player with rackmount installed in the rack.
6. Provide one (1) Denon DN200BR bluetooth receiver and install in the equipment rack.

7. Provide one (1) Soundcraft Ui16 - sixteen channel remote controlled Digital Mixing console (Equal by Allen & Heath) The console shall be feed by the microphone receptacles located on the stager, the overhead microphones, the Audio player and the Wireless microphones. The unit is controlled via Tablet, PC or smartphone.
 8. Provide two (2) Shure SLXD4D dual channel wireless mic system receivers. Provide rackmount hardware required. Provide four (4) Shure SLXD1 bodypack transmitters. Provide one (1) SLXD2/58 Handheld microphone transmitters. Provide four (4) Shure WL185 lavalier microphones. Provide required rackmount hardware and antenna distribution as required for reception throughout the entire room. Audio Technica and Electro-Voice Series shall be considered equal. All wireless microphones on the project shall be the same series for interchangeability.
 9. Provide three (3) Shure Model MX202B/C hanging microphones each with a premium heavy-duty 25' XLR cable for use in the MPR.
 10. All necessary power supplies, relays, connectors, and hardware necessary to provide remote switching functions as described shall be provided.
Provide one (1) Middle Atlantic Products Model DWR-24-22, pivoting, sectional wall mount rack with 24RU of rack space and the following items:
 - a. Middle Atlantic Products Model PDS-915R rack mount power distribution panel.
 - b. Middle Atlantic Products Model FD24 front door.
 - c. Middle Atlantic Products Model TD-4 rack mount 4RU drawer.
 - d. Provide additional cabinet space if necessary for adequate panel space with a single space vent panel separating each active device or manufacturer's recommendations for amplifier cooling.
 - e. All equipment mounting hardware required.
 - f. Blank and vented panels to fill rack.
- B. Loudspeakers
1. Provide two (2) JBL Model CBT-1000 Line Array Column loudspeaker systems, as detailed on the drawings. Provide two (2) CBT-1000E Line Array Column extension loudspeakers. Provide all mounting hardware as required. All should be colored black.
 2. Provide two (2) JBL Model PRX412 – 12" two-way stage monitor loudspeakers. Provide 50' monitor cables with ¼" jacks.
- C. Video System
1. Provide one (1) Atlona AT-UHD-SW5000ED Media Switcher with AT-VGW-HW-3 Media Gateway and install in the sound system equipment cabinet. The media switcher shall be capable of passing HDCP. Provide audio output connection to the sound system matrix.
 2. Provide two (2) Atlona AT-VKP-8E Network LCD Control Panels and install at the location shown on the Drawings. The panels shall control projector power, projector audio and selections of inputs.
 3. Provide one (1) 8-port unmanaged PoE+ switch.
 4. Provide two (2) Atlona AT-HDVS-200-TX-WP wall plate transmitter and install at the location shown on the drawings.
 5. Provide one (1) Atlona AT-UHD-ES-70C-RX Projector HDMI Receiver.
- D. Video Projection System
1. Provide one (1) Epson EB-PU1008B - 16:10 WUXGA projector on the stage. Provide appropriate lens to fill the permanent ceiling mount rear projection screen as shown on

drawings. The projector shall meet these minimum specifications at the time of installation. No substitutions shall be accepted.

- a. Resolution: WUXGA (1,920 x 1200)
 - b. Brightness: 8,500 ANSI lumens
 - c. Contrast Ratio: 2,500,000:1
 - d. Aspect Ratio: 16:10, 4:3, 16:9 Compatible
 - e. Motorized lens shift and power zoom/focus
2. Provide Chief Model RPA-W mount and pipe in required length for the projector. Provide Chief Model WMA-2S – projector wall mount arm.
 3. Provide one (1) Da-Lite 70278L – wall mounted, rear projection, Tensioned Advantage Screen – 226” diagonal – 16:10 format. Install in location as shown on the drawings.

2.2 CAFETERIA B123

A. Sound Equipment

1. Provide one (1) JBL CSM-28 8-Input Mixer/Preamplifier.
2. The Power amplifier shall be multi-speed fan cooled to reduce cleaning requirements and incorporate a fully-programmable DSP. Provide by one (1) Crown Model CDi 2 | 300 for the loudspeakers.
 - a. Amplifiers must have rear panel or defeatable level controls.
 - b. Amplifiers by QSC or LabGruppen shall be considered as equal.
3. The local multi-format audio player shall be Tasam Model CD-400U – CD player with ¼” auxiliary input, Bluetooth and USB with rackmount located in the equipment rack.
 - a. Provide one (1) audio player with rackmount installed in the rack.
4. Provide one (1) Middle Atlantic Products Model DTRK-18-18, desk-top rack with 18RU of rack space with the following items (Contractor to verify casework size):
 - a. Middle Atlantic Products Model PDS-620R rack mount power sequencer.
 - b. Middle Atlantic Products Model TD2LK 2- space rack drawer with lock.
 - c. Middle Atlantic Products Model DT-VFD-14 vented front door.
 - d. Middle Atlantic Products Model 5-RS18 low friction glide rails.

B. Loudspeakers

1. Provide eighteen (18) JBL Model Control 26T Recessed Ceiling Speaker Assemblies. Install at locations shown on the drawings.

C. Microphones

1. Provide one (1) Shure SLXD4D dual channel wireless mic system receiver. Provide rackmount hardware required. Provide two (2) Shure SLXD2/58 handheld microphone transmitters. Provide rackmount hardware required. Provide antenna distribution as required.
 - a. Audio Technica and Electro-Voice Series shall be considered equal. All wireless microphones on the project shall be the same series for interchangeability.
2. Provide two (2) Shure SM58S dynamic handheld microphones, each with Atlas Model TB3664 adjustable tripod microphone stand with boom arm, and each with premium heavy duty 25’ XLR cable.
 - a. Similar microphones by AKG or Audio shall be acceptable.

D. Video System

1. Provide one (1) Atlona AT-HDR-UHD-CLSO-824 Matrix Switcher and install in the sound system equipment cabinet. The media switcher shall be capable of passing HDCP. Provide audio output connection to the sound system matrix.
2. Provide one (1) Atlona AT-VKP-8E Network LCD Control Panels and install at the location shown on the Drawings. The panels shall control projector power, projector audio and selections of inputs.
3. Provide one (1) 8-port unmanaged PoE+ switch.
4. Provide one (1) Atlona AT-HDVS-200-TX-WP wall plate transmitter and install at the location shown on the drawings.
5. Provide one (1) Atlona AT-UHD-ES-70C-RX Projector HDMI Receiver.

E. Video Projection System

1. One (1) ceiling mounted projectors provided by Owner and installed by Electrical Contractor.
2. Provide one (1) Da-Lite 29929LS – wall mounted Tensioned Advantage Screen – 130” diagonal – 16:10 format. Install in location as shown on the drawings.

2.3 MUSIC C112

A. Sound Equipment

1. Provide one (1) Tascam Model 12 – All-in-One production mixer. Unit shall have built-in audio recorder, USB/Midi Interface, twelve mic/line inputs and SD Card slot.
2. The Main Power amplifiers shall be multi-speed fan cooled to reduce cleaning requirements. Provide by one (1) Crown Model CDi 2|300 for the loudspeakers.
 - a. Amplifiers must have rear panel or defeatable level controls.
 - b. Amplifiers by QSC or LabGruppen shall be considered as equal.
3. The local multi-format audio player shall be Tasam Model CD-400U – CD player with ¼” auxiliary input, Bluetooth and USB with rackmount located in the equipment rack.
 - a. Provide one (1) audio player with rackmount installed in the rack.
4. Provide one (1) Middle Atlantic Products Model DTRK-18-18, desk-top rack with 18RU of rack space with the following items (Contractor to verify casework size):
 - a. Middle Atlantic Products Model PDS-620R rack mount power sequencer.
 - b. Middle Atlantic Products Model TD2LK 2- space rack drawer with lock.
 - c. Middle Atlantic Products Model DT-VFD-14 vented front door.
 - d. Middle Atlantic Products Model 5-RS18 low friction glide rails.
 - e. Middle Atlantic Products Model SSL sliding shelf.

B. Loudspeakers

1. Provide two (2) JBL Model Control 31 – Two-Way High-Output monitor loudspeakers. Install at locations shown on the drawings.

C. Microphones

1. Provide one (1) Shure SLXD4D dual channel wireless mic system receivers. Provide rackmount hardware required. Provide one (1) Shure SLXD1 bodypack transmitter. Provide one (1) SLXD2/58 handheld microphone transmitters. Provide one (1) Shure WBH54 headworn microphone. Provide rackmount hardware required. Provide antenna distribution as required.

- a. Audio Technica and Electro-Voice Series shall be considered equal. All wireless microphones on the project shall be the same series for interchangeability.
2. Provide two (2) Shure SM58S dynamic handheld microphones, each with Atlas Model TB3664 adjustable tripod microphone stand with boom arm, and each with premium heavy duty 25' XLR cable.
 - a. Similar microphones by AKG or Audio shall be acceptable.
3. Provide one (1) Rapco Horizon Model ProCO AV-1A direct box with volume control for use with the system.

2.4 INSTRUMENTAL C113

A. Sound Equipment

1. Provide one (1) Tascam Model 12 – All-in-One production mixer. Unit shall have built-in audio recorder, USB/Midi Interface, twelve mic/line inputs and SD Card slot.
2. The Main Power amplifiers shall be multi-speed fan cooled to reduce cleaning requirements. Provide by one (1) Crown Model CDi 2|300 for the loudspeakers.
 - a. Amplifiers must have rear panel or defeatable level controls.
 - b. Amplifiers by QSC or LabGruppen shall be considered as equal.
3. The local multi-format audio player shall be Tasam Model CD-400U – CD player with ¼" auxiliary input, Bluetooth and USB with rackmount located in the equipment rack.
 - a. Provide one (1) audio player with rackmount installed in the rack.
4. Provide one (1) Middle Atlantic Products Model DTRK-18-18, desktop rack with 18RU of rack space with the following items (Contractor to verify casework size):
 - a. Middle Atlantic Products Model PDS-620R rack mount power sequencer.
 - b. Middle Atlantic Products Model TD2LK 2- space rack drawer with lock.
 - c. Middle Atlantic Products Model DT-VFD-14 vented front door.
 - d. Middle Atlantic Products Model 5-RS18 low friction glide rails.
 - e. Middle Atlantic Products Model SSL sliding shelf.

B. Loudspeakers

1. Provide two (2) JBL Model Control 31 – Two-Way High-Output monitor loudspeakers. Install at locations shown on the drawings.

C. Microphones

1. Provide one (1) Shure SLXD4D dual channel wireless mic system receivers. Provide rackmount hardware required. Provide one (1) Shure SLXD1 bodypack transmitter. Provide one (1) SLXD2/58 handheld microphone transmitters. Provide one (1) Shure WBH54 headworn microphone. Provide rackmount hardware required. Provide antenna distribution as required.
 - a. Audio Technica and Electro-Voice Series shall be considered equal. All wireless microphones on the project shall be the same series for interchangeability.
2. Provide two (2) Shure SM58S dynamic handheld microphones, each with Atlas Model TB3664 adjustable tripod microphone stand with boom arm, and each with premium heavy duty 25' XLR cable.
 - a. Similar microphones by AKG or Audio shall be acceptable.
3. Provide one (1) Rapco Horizon Model ProCO AV-1A direct box with volume control for use with the system.

D. Video System

1. Provide one (1) Atlona AT-HDR-UHD-CLSO-824 Matrix Switcher and install in the sound system equipment cabinet. The media switcher shall be capable of passing HDCP. Provide audio output connection to the sound system matrix.
2. Provide one (1) Atlona AT-VKP-8E Network LCD Control Panels and install at the location shown on the Drawings. The panels shall control projector power, projector audio and selections of inputs.
3. Provide one (1) 8-port unmanaged PoE+ switch.
4. Provide one (1) Atlona AT-HDVS-200-TX-WP wall plate transmitter and install at the location shown on the drawings.
5. Provide two (2) Atlona AT-UHD-ES-70C-RX at the Projector and TV HDMI Receiver.

E. Video Projection System

1. One ceiling mounted projector provided by Owner and installed by Electrical Contractor.
2. Provide one (1) Da-Lite 34521LS – Advantage Screen – 130” diagonal – 16:10 format. Install in location as shown on the drawings.

2.5 INSTRUMENTAL C129

A. Sound Equipment

1. Provide one (1) Tascam Model 12 – All-in-One production mixer. Unit shall have built-in audio recorder, USB/Midi Interface, twelve mic/line inputs and SD Card slot.
2. The Main Power amplifiers shall be multi-speed fan cooled to reduce cleaning requirements. Provide by one (1) Crown Model CDi 2|300 for the loudspeakers.
 - a. Amplifiers must have rear panel or defeatable level controls.
 - b. Amplifiers by QSC or LabGruppen shall be considered as equal.
3. The local multi-format audio player shall be Tascam Model CD-400U – CD player with ¼” auxiliary input, Bluetooth and USB with rackmount located in the equipment rack.
 - a. Provide one (1) audio player with rackmount installed in the rack.
4. Provide one (1) Middle Atlantic Products Model DTRK-18-18, desktop rack with 18RU of rack space with the following items (Contractor to verify casework size):
 - a. Middle Atlantic Products Model PDS-620R rack mount power sequencer.
 - b. Middle Atlantic Products Model TD2LK 2- space rack drawer with lock.
 - c. Middle Atlantic Products Model DT-VFD-14 vented front door.
 - d. Middle Atlantic Products Model 5-RS18 low friction glide rails.
 - e. Middle Atlantic Products Model SSL sliding shelf.

B. Loudspeakers

1. Provide two (2) JBL Model Control 31 – Two-Way High-Output monitor loudspeakers. Install at locations shown on the drawings.

C. Microphones

1. Provide one (1) Shure SLXD4D dual channel wireless mic system receivers. Provide rackmount hardware required. Provide one (1) Shure SLXD1 bodypack transmitter. Provide one (1) SLXD2/58 handheld microphone transmitters. Provide one (1) Shure WBH54 headworn microphone. Provide rackmount hardware required. Provide antenna distribution as required.

- a. Audio Technica and Electro-Voice Series shall be considered equal. All wireless microphones on the project shall be the same series for interchangeability.
2. Provide two (2) Shure SM58S dynamic handheld microphones, each with Atlas Model TB3664 adjustable tripod microphone stand with boom arm, and each with premium heavy duty 25' XLR cable.
 - a. Similar microphones by AKG or Audio shall be acceptable.
3. Provide one (1) Rapco Horizon Model ProCO AV-1A direct box with volume control for use with the system.

D. Video System

1. Provide one (1) Atlona AT-HDR-UHD-CLSO-824 Matrix Switcher and install in the sound system equipment cabinet. The media switcher shall be capable of passing HDCP. Provide audio output connection to the sound system matrix.
2. Provide one (1) Atlona AT-VKP-8E Network LCD Control Panels and install at the location shown on the Drawings. The panels shall control projector power, projector audio and selections of inputs.
3. Provide one (1) 8-port unmanaged PoE+ switch.
4. Provide one (1) Atlona AT-HDVS-200-TX-WP wall plate transmitter and install at the location shown on the drawings.
5. Provide two (2) Atlona AT-UHD-ES-70C-RX at the Projector and TV HDMI Receiver.

E. Video Projection System

1. One ceiling mounted projector provided by Owner and installed by Electrical Contractor.
2. Provide one (1) Da-Lite 34521LS – Advantage Screen – 130" diagonal – 16:10 format. Install in location as shown on the drawings.

2.6 ASSISTIVE LISTENING SYSTEMS

- A. The Multipurpose and Cafeteria sound system shall each be provided with a Williams PPA T55 assistive listening transmitter, PPA R38 multi-channel receivers with EAR 022, alkaline batteries, high-gain remote antenna, and necessary interface(s). Provide a minimum of ten (10) multi-channel receivers with earbuds and alkaline batteries for each system. Equal equipment by Listen Technologies shall be acceptable.
1. Provide hearing aid neckloops to meet ADA requirements with the system.
 2. Provide a quantity of receivers and neckloops per IBC Table 1108.2.7.1 for each specified system.
 3. Provide multi-channel receivers that can be shared between all systems.

2.7 TAKEOVER OF SYSTEMS

- A. For each sound system, provide a dry contact closure to interface the local sound system with the building fire alarm system. A fire alarm signal shall immediately bring the local sound system to mute or turn the system off.
- B. For each sound system provide a muting input to interface the local sound system with the paging system. The presence of a signal on the paging system shall mute the output of the local sound system.

2.8 AUDIO/VISUAL WIRING

- A. Manufacturers
 - 1. Commscope
 - 2. Belden
 - 3. West Penn
- B. Wiring type and size shall be as recommended by the system manufacturer.
- C. All sound system low impedance loudspeaker wiring shall be 14-awg twisted/stranded minimum.
- D. All microphone wiring shall be 22-awg twisted/shielded/stranded.
- E. All wiring shall be plenum rated.

2.9 REMOTE SYSTEM ACCESSORIES

- A. Single microphone receptacles shall be Conquest Model CP1DF. Provide in the locations and quantities as shown on the plans.
- B. Multiple mic receptacles shall be Switchcraft Model D3F with 2 on a single plate or 4 on a 2-gang plate. Provide in the locations and quantities as shown on the plans.
- C. Stage monitor loudspeaker receptacles shall be Rapco Model SP1-3FP6C. Provide 1 on either side of the stage for each monitor speaker provided and any additional shown on the plans.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with installation instructions provided by system manufacturer.
- B. Provide wiring as required for the system.
- C. Wiring Methods:
 - 1. 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.
 - 2. 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.
 - 3. Route all system wiring from 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 cabling in all open structure spaces.

- D. Cable identification shall be provided on both ends of each cable and termination with the Owners room number and the wiring block or device to which it is connected. Tags shall be permanent and neat.
- E. Provide necessary conduit, raceways, pull boxes, outlet boxes and wire to provide a complete and operational system.
- F. All wiring shall be tested for continuity and freedom of all grounds and short circuits.
- G. Each cable run between the console and remote locations shall be one continuous cable. System cable shall not share conduit with any other system.
- H. Each rack shall be provided with a 10AWG ground wire to earth ground. Conduit ground shall not be acceptable for this purpose.
- I. Provide a microphone jack with wiring/conduit back to sound rack for each hanging microphone.

3.2 DEMONSTRATION

- A. Perform demonstration at final system inspection by qualified representative of manufacturer.
- B. Conduct walking tour of project and briefly describe function, operation, and maintenance of each component.

3.3 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, 4-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.

END OF SECTION 277000

SECTION 278000 – AUDIO/VISUAL SUPPORT EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all equipment associated with the installation of the audio/visual support equipment for the rooms indicated. This work shall include an audio/visual system, amplifiers, loudspeakers, outlets and wiring as required for a complete and operating system.

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 equipment to be provided and installed.
 - c. Data sheets of all items to be provided with specific item or model number highlighted.
 - d. Basic riser diagram for each system to include all equipment and all wiring required.

1.3 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of equipment provided.

1.4 QUALIFICATIONS

- A. Manufacturer: Equipment manufactured by those as listed shall be considered as meeting these specifications. The naming of the manufacturer or item of material is not intended to be restrictive, but rather to establish criteria for design and quality. Catalog and model numbers are intended to indicate type, quality of design, material, as well as exact operating features required.
- B. Other manufactures shall be considered for use if submitted for approval 10 days before the published bid date. The alternate system submission shall include all inter-panel block wiring diagrams for systems where product substitution is requested. Any prior approval of an alternate system does not automatically exempt the alternate supplier from meeting the intent of these specifications. Final approval of the alternate system shall be determined at the time of job completion. Failure to provide the “precise functional equivalent” shall result in the removal of the system at the contractor’s expense. The submittal shall include published literature which clearly indicates specific compliance of products with requirements of this specification.

- C. Supplier/Installer: The supplier must have a minimum of five years' experience in the design and installation of systems equal in size and type required by this project. The supplier must maintain a local service organization within a one hundred (100) mile radius of the installation with spare service replacement boards, components, and accessories.
- D. The supplier/installer must be the authorized representative of the equipment manufacturer supplied and have full-time technicians trained and certified in the installation and service of the equipment supplied.

1.5 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. HDMI Outlet: Furnish 1 of each type and rating installed.

1.6 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide every room shown with a display (TV outlet) on the drawings with the equipment specified below:

2.2 HDMI/USB OUTLETS

- A. Provide (1) Hubbell Model ISFHD5BK-110 HD Base T HDMI Extender Kit. Install at TV and TS outlets shown on the Drawings. Acceptable alternates would consist of an Atlona AT-HDVS-150-TX and AT-HDVS-150-RX pair with a AT-USB-EX100-KIT; or an Extron DTP-T-HWP-4K-331-D and DTP-R-HWP-4K-331-D pair-and USB Extender Plus D T and USB Extender Plus D R.
- B. Provide (2) Hubbell Model HDMIDC5V External Power Supplies (Display and Source) or equivalent from Atlona or Extron.
- C. Provide (1) Category 6A cable between the two units.
 - 1. Category 6A cables shall be per Division 27.
- D. Provide HDMI and USB patch cables as required to connect to the display.
- E. Owner will provide patch cables at the TS and PI Outlets.

2.3 DISPLAY BRACKET

- A. Furnished by Owner and installed by the Electrical Contractor.

2.4 DISPLAY

- A. Furnished by Owner and installed/wired by the Electrical Contractor.
- B. Electrical Contractor to provide outlet splitters or surge strips as needed for all items to plug into the outlets shown on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Coordinate the projector/display locations shown on the Architectural Drawings with the Owner before rough-in.
- B. Verify all dimensions with General Contractor before installing mounting.

3.2 INSTALLATION

- A. Comply with installation instructions provided by system manufacturer.
- B. Provide wiring as required for the system.
- C. Category 6A installation shall meet the requirements of Division 27.
- D. Wiring Methods:
 - 1. 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.
 - 2. 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.
 - 3. Route all system wiring from 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 cabling in all open structure spaces.
- E. Cable identification shall be provided on both ends of each cable and termination with the Owners room number and the wiring block or device to which it is connected. Tags shall be permanent and neat.
- F. Provide necessary conduit, raceways, pull boxes, outlet boxes and wire to provide a complete and operational system.
- G. All wiring shall be tested for continuity and freedom of all grounds and short circuits.
- H. Provide additional supports and blocking required for projector mounts.

3.3 DEMONSTRATION

- A. Perform demonstration at final system inspection by qualified representative of manufacturer.
- B. Conduct walking tour of project and briefly describe function, operation, and maintenance of each component.

3.4 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 1-hour session to demonstrate the system.
 - 3. Provide documentation of sessions to Architect/Engineer with signatures of at least 3 Owners Representatives present at demonstration.

END OF SECTION 278000

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.

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.
 5. Non-continuous cable supports shall be UL listed, with manufacturer's name and part number stamped on.

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. Comply with all installation requirements of Sections 260529.

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 1 inch.

3.5 SLEEVE INSTALLATION FOR PENETRATIONS

- A. Penetrations occur when pathways, cables or wireways 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.
- 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. 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 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.

END OF SECTION 280500

SECTION 281300 – EXPANSION OF THE EXISTING ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all equipment associated with the installation of the Access Control System. This work shall include a control panel, card readers, door contacts and wiring as required for a complete and operating system. Refer to Door Hardware Schedule.

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 equipment to be provided and installed in the system.
 - c. Data sheets of all items to be provided with specific item or model number highlighted.
 - 2. Provide system drawings, prepared in AutoCAD, to include the following:
 - a. Indicate all system device locations on architectural floor plans. No other system(s) shall be included on these plans.
 - b. Basic riser diagram to include all equipment and all wiring required.

1.3 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of all equipment.

1.4 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. Card Reader: Furnish 1 of each type and rating installed.
 - 2. Door Position Contacts: Furnish at least 2 of each type and rating installed.

1.5 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. LenelS2
 - 1. The school district uses a Lenel S2 security and access control system.
- B. Supplier:
 - 1. Advanced Electronic Security
Jeremy Kozich
Office: 484 873 8383
Mobile: 484 369 3850
Email: jkozich@aessecurity1.com

2.2 CARD READER

- A. HID Global, Signo40, Wall Mount, 13.56mHz & 125kHz, OSDP/Wiegand, Pigtail, Mobile Ready.
 - 1. Model 40NKS-00-000000
- B. Provide card readers at the locations shown on drawings.

2.3 DOOR POSITION SWITCHES

- A. Tane Alarm Products, Gap 1.1", CLOSED, 12" leads
 - 1. Model BSD-70 WH
- B. Provide door position switches at all access control doors.

2.4 REQUEST-TO-EXIT SENSOR WITH SOUNDER

- A. Bosch, REQUEST-TO-EXIT SENSOR
 - 1. Model DS160
- B. Provide request to exit sensors at all the access control doors.

2.5 LOCK POWER SUPPLY

- A. Altronix Power Supply
 - 1. Model AL600ULACM
- B. Provide power supplies as required to power all equipment provided.

2.6 S2 NETWORK NODE

- A. S2 Network Node
 - 1. Model S2-NN-E2R-WM

- B. Provide as required for the project.

2.7 S2 ACM BLADE

- A. S2 ACM BLADE
 - 1. Model S2-ACM

- B. Provide as required for the project.

2.8 S2 MICRONODE

- A. S2 MICRONODE
 - 1. Model S2-MNP

- B. Provide as required for the project.

2.9 ACCESS CONTROL SOFTWARE

- A. S2 Netbox
- B. Provide upgrades as required for the existing district wide access control system.

2.10 COMPOSITE ACCESS CONTROL CABLING

- A. Plenum 4 Element Access Control Cable 18-04 Lock Power, 22-3P OAS Card Reader, 22-02 Door Contact, 22-04 REX.
 - 1. Model Windy City Wire, 4461060
- B. Provide as required for the project.

2.11 16 DOOR INTELLIGENT CONTROLLER (PIM)

- A. Schlage 16-door Intelligent Controller for AD Series Wireless Devices
 - 1. Model PIM400-1501-LC
- B. Provide as required for the project.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with installation instructions provided by system manufacturer.
- B. Provide 20A/1P breaker in nearest 120/208V normal/emergency panelboard and connect to the control panels with 2#10 + 1#10 GND in 3/4" conduit unless otherwise noted.
- C. Provide wiring as required for the system.

D. Wiring Methods:

1. 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.
2. Cable Routing: Route cable for all device wiring within accessible ceiling cavities. Install in J-hooks at 4' spacing maximum to panel. 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 intrusion detection wiring from panel 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 cabling in all open structure spaces.

E. Provide necessary conduit, raceways, pull boxes, outlet boxes and wire to provide a complete and operational system.

F. Provide interface wiring and equipment to interface system to building local area network, and telephone system.

G. Provide interface wiring and equipment to interface the intrusion detection system.

3.2 PROGRAMMING AND TESTING

A. After completion of the installation of the system and before the system is turned over to the Owner, the system shall be programmed as required by the Owner for proper operation.

3.3 DEMONSTRATION

A. Perform demonstration at final system inspection by qualified representative of manufacturer.

B. Conduct walking tour of project and briefly describe function, operation, and maintenance of each component.

3.4 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 1-hour session to demonstrate the system.
3. Provide documentation of sessions to Architect/Engineer with signatures of at least 3 Owners Representatives present at demonstration.

END OF SECTION 281300

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 6A installation shall meet all requirements of Division 27.
- B. Interior Cameras: Provide (1) Category 6A cable to nearest IDF/MDF with connections on each end. Refer to Detail on the Drawings.
- C. Exterior Cameras: Provide (1) Category 6A 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

SECTION 282400 – CAMERA INTERCOM SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. IP Video Intercom. (Aiphone IX Series)

1.2 REFERENCES

- A. American National Standards Institute (ANSI/TIA/EIA) 568 - Commercial Building Telecommunications Cabling Standard.
- B. International Organization for Standards (ISO) 9001:2000 - Quality Management Systems - Requirements.

1.3 SYSTEM DESCRIPTION

- A. IP Network Compatible Video Intercom System: A network-based communication and security system featuring video entry security, internal communication, emergency stations, and paging. All units and app in the systems shall be able to unlock doors remotely on a network, assist onsite visitors from an offsite location, broadcast emergency announcements, and communicate using a PoE network.
 - 1. Power Source: Power over Ethernet (802.3af).
 - 2. Network Interface: 10 BASE-T / 100 BASE-TX Ethernet (RJ-45).
 - 3. Network Protocols: IPv4, IPv6, TCP, UDP, SIP, HTTP, HTTPS, MJPEG, RTSP, RTP, RTCP, IGMP, MLD, SMTP, DHCP, NTP, DNS.
 - 4. Bandwidth Usage:
 - a. G.711, G.7.22: 64Kbps x 2 per video call.
 - b. 64Kbps per monitor.
 - c. H.264: 24Kbps ~ 2,048Kbps.
 - 5. Communication: Hands-free (VOX), push-to-talk (simplex), or handset (full-duplex).
 - 6. Video Display: 7" TFT color LCD touchscreen.
 - 7. Camera: Type:
 - a. 1/3" color CMOS 1.23 megapixel.
 - b. View Area: 2'- 2" (660 mm) vertical x 3'-1" (940 mm) horizontal at 20" (508 mm).
 - 8. Video Stream: ONVIF Profile S.
 - 9. Door Release: Programmable Form C dry contact, 24V AC/ DC, 500mA (use RY-24L for larger contact rating, which requires 24V DC power supply) or use RY-IP44 with 4 multipurpose relays.
 - 10. Wire Type: CAT-6.
 - 11. Distance: Any station to Network Node: 330' (100 meters).

1.4 SUBMITTALS

- 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:
 2. Reference to Specification Section.
 3. A list of all equipment to be provided and installed.
 4. Data sheets to indicate equipment to be supplied with installation instructions and system wiring diagrams with specific item or model number highlighted.
 5. Basic wiring diagram of the system.
 6. Preparation instructions and recommendations.
 7. Storage and handling requirements and recommendations.
 8. Installation methods.
 9. Include manufacturer's names, model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts
 10. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001:2008 certified company. Deming Prize Award TQM.
- B. Installer Qualifications: Factory trained and experienced with system installations of scope and size required for the Project.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
1. Finish areas designated by Architect.
 2. Do not proceed with remaining work until workmanship is approved by Architect.
 3. Refinish mock-up area as required to produce acceptable work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
- C. Handling: Protect materials during handling and installation to prevent damage.

1.7 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.

1.8 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Aiphone Corporation: IP Video Intercom System: IX Series Intercom System as manufactured by Aiphone Corporation.

2.2 MASTER MONITOR STATION

- A. Provide Aiphone model IX-MV7-HX-L Touchscreen Master Station with T-coil supported Handset for the IX Series at the locations shown on the Drawings.
- B. Architect to select color. (White or Black)
- C. Provide power supplies as required.

2.3 DOOR ENTRANCE STATION

- A. Provide Aiphone model IX-DVF-HW IP Addressable Video Door Stations with hand wave for the IX Series at the locations shown on the Drawings.
- B. Provide Contact input at door station.

2.4 FUNCTIONAL COMPONENTS

- A. Provide the following components as required for a complete system.
 - 1. IXW-MA IP Programmable Relay Adaptor: 4 contact inputs and 10 relay outputs

2.5 LOUD RINGER

- A. Provide relay output on master station to activate the loud ringer.
- B. Provide Edwards Model 598-120/24-volt transformer. Locate by the loud ringer.
- C. Provide Edwards Model 156G-4G5 – loud ringer.
- D. Provide Class 2, 18-ga wiring in 3/4" conduit and connect as required. Connect transformer to local receptacle circuit.
- E. Location: Kitchen and Front Main Entrance

2.6 CABLES

- A. Provide UTP cables as specified in Division 27 from equipment to network racks in IDF/MDF Rooms.
- B. UTP cables for camera/intercom system shall be a different color than the UTP data cables.

2.7 PATCH PANELS

- A. Provide UTP rack mounted patch panels as specified in Division 27. Equipment 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 EXAMINATION

- A. Examine areas to receive integrated security and communication system.
- B. Notify Architect of conditions that would adversely affect installation or subsequent use.
- C. Do not begin installation until unacceptable conditions are corrected.

3.2 PREPARATION

- A. Verify the following compliance before starting installation.
 - 1. The unit turns inoperative during power failure.
 - 2. Keep the intercom wires at least 1' (30 cm) away from strong electrical wiring (AC 100-240 V) including in particular wiring for inverter electrical appliances. Noise and malfunction could result.
 - 3. If a strong light shines on the main unit screen, the picture may turn white or only silhouettes will be visible.
 - 4. Other manufacturer's devices (such as sensor, detectors, door releases) used with this system, comply with the manufacturer's installation requirements.
 - 5. The LCD panel is manufactured with very high precision techniques, inevitably will have a very small portion of its picture elements always lit or not lit at all. This is not considered a unit malfunction. Please be aware of this in advance.

3.3 INSTALLATION

- A. Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Mount equipment plumb, level, square, and secure. For video entrance stations and video door stations, comply with manufacturer's design requirements to provide optimum picture quality of station monitoring.

- C. Installation shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work.
- D. Install all wiring in accordance with manufacturer's and UL recommendations.
- E. Wiring Methods:
 - 1. 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.
 - 2. Cable Routing: Route all cable for all device wiring within accessible ceiling cavities. Install in J-hooks 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.
 - 3. Route all wiring from system equipment 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.
 - 4. Provide raceways for all cabling in open structure spaces.
- F. Provide wiring and connections to access control system as required.
- G. Category 6A installation shall meet all requirements of Division 27.
- H. Install PS-PoE for touchless calling adapter in box above ceiling with wiring/conduit to door entrance station.

3.4 SET-UP AND ADJUSTING

- A. Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

3.5 DEMONSTRATION

- A. Demonstrate that IP video intercom adaptors function properly.
- B. Perform demonstration at final system inspection by qualified representative of manufacturer.
- C. Conduct walking tour of project and briefly describe function, operation, and maintenance of each component.
- D. Instruction and Training:
 - 1. Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.
 - 2. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
 - 3. Provide instruction and training by qualified representative of manufacturer.

3.6 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 1-hour session to demonstrate the system.
 - 3. Provide documentation of sessions to Architect/Engineer with signatures of at least 3 Owners Representatives present at demonstration.

3.7 PROTECTION

- A. Protect installed integrated security and communication system from damage during construction.

END OF SECTION 282400

SECTION 283110 – EXPANSION OF THE EXISTING FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Automatic Initiating Devices
- B. Notification Appliances
- C. 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. The Fire Alarm System work shall include revisions and extensions of the existing voice notification Fire Alarm System. New devices shall be connected to the existing Fire Alarm Cabinets. New extender panels shall be provided if required for communicating with the existing Fire Alarm System. The system shall include all fire alarm control panel upgrades, manual stations, audible and visual notification appliances, detectors, interface relays, alarm devices,

wiring and any other appurtenances necessary for complete and operational system. Provide all additional power supplies and circuits as required.

- B. Work shall be constructed in phases. Fire Alarm System shall remain operational during all construction phases and shall be programmed/tested for each phase.

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:
 - 3. All control equipment with interconnecting wiring
 - a. Field connections of all circuits connecting to the control equipment
 - b. Floor layouts with fire alarm system device locations shown
 - c. Addressable device numbers for each addressable device
 - d. Notification appliances circuited and numbered, with candela setting for visual units and output setting for audible units
 - e. Typical device connections for each type device used in the system
 - f. Basic riser diagram to include control equipment and all field circuits
 - g. 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.

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 UUIS 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.
 - 2. The proposal shall include the cost for re-certifying (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.

1.11 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS AND OPERATIONS

2.1 MANUFACTURER

- A. Expansion of the existing Notifier Fire Alarm System. All equipment provided shall be from this manufacturer and compatible with the existing system.

2.2 FIRE ALARM AND AUTOMATIC DETECTION CONTROL UNIT

- A. Control Panel: Provide upgrades to existing fire alarm panels, including necessary I/O boards, power supplies, etc. to accommodate additional alarm devices added to the building.
 - 1. Provide all programming and testing of system to verify operational status.
- 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 60 devices without short-circuit protection. Circuits over 60 devices shall require circuit isolation modules to prevent short-circuits from affecting more than 60 devices. Each initiating device circuit shall be loaded to not more than 80% of its maximum number of addresses.
- E. 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.
- F. 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.

- G. 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 first-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.
- H. 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.
- I. 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.
- J. 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.
- K. 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.
- L. 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.
- M. Function Switches: Included on all Remote Annunciators 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
 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.
- N. 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.

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 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.

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.
 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 Test Stations: Provide remote test stations as required. All duct smoke detectors installed over 10' above the finished floor or installed in concealed space shall be provided with a Remote Test Station consisting of alarm LED and test switch installed below the unit in order to facilitate locating the unit for testing and maintenance purposes. Coordinate remote test station locations with Owner/Architect before roughing-in.

- 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, and thermostat.

2.8 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. 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. Air-Handling Unit Control
 - 2. Ancillary Fire Protection Systems
- 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.

2.9 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.
- 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.

2.10 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.

2.11 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

2.12 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.

2.13 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 to meet the International Building Code per letter filed with Department of Labor & Industry.
 3. Audible and Visual Notification Appliances-Special Circumstances:
- 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. Extender Panel Power: Provide 1P.20A breaker in closest normal panel and connect to fire alarm extender panel with 2 #12 + 1 #12 GND in 3/4" conduit unless otherwise indicated.
- I. 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.
- J. Provide fire alarm breaker lockout for all circuit breakers feeding fire alarm equipment.
- K. Provide system record document box at location coordinated with Owner/Architect/Engineer.
- L. 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.
- M. 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.
- N. 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.
- O. 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.
- P. Install the elevator smoke detectors, heat detectors, and control circuits per NFPA 72 and all applicable codes.
- Q. 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.
- 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.

END OF SECTION 283110

SECTION 283220 – EMERGENCY COMMUNICATION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all equipment associated with the installation of the Emergency Communication System designed for IBC (International Building Code) and ADA (Americans with Disabilities Act) requirements. This work shall include an emergency communications panel, area of rescue assistance remote stations, power supply, voice communication wiring and signage as required for a complete and operating system.
- B. This system is for 1-10 remote stations.

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code
- B. NFPA 72 – Fire Alarm Code
- C. ADA – Americans with Disabilities Act
- D. NFPA 101 – Life Safety Code
- E. IBC – International Building 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.
 - c. Data sheets to indicate specific items or model number highlighted.
 - d. Annunciator layout and system wiring diagram showing each device and connection required.
 - e. Cabling
 - f. Submit manufacturers' installation instructions.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of base station and call boxes.

- C. Test Reports: Indicate satisfactory completion of required tests and inspections.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum 3 years documented experience and with service facilities within 100 miles of project.
- B. Installer: Company specializing in installing the products specified in this section with minimum three years documented experience.

1.6 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Rath Communications
- B. Alternate manufacturers as listed below:
 - 1. Cornell Communications, Inc. – 4800 series

2.2 SYSTEM OPERATION

- A. Provide a complete Emergency Communication System for this building as indicated on the drawings and as specified herein.
- B. A common annunciator shall be provided at the main entrance to indicate light and tone signals from multiple remote call stations and allow voice communication.
 - 1. When the system is operational, a LED signals power on.
 - 2. When the call station switch is activated, a red LED button illuminates and a 1-shot tone sounds.
 - 3. When the alarm signal is acknowledged, the remote call station is signaled with a flashing light and tone.
 - 4. Voice communication with the remote call station can then be initiated from the control panel via a handset.
 - 5. The system shall poll (supervise) all the call stations, control panels and field switches on a continuous basis at least every 200 seconds to identify line faults and defective equipment. Faults will be alerted and displayed at the control panel.
- C. Verify locations of all equipment with the local fire marshal and Architect before rough-in.

2.3 EMERGENCY COMMUNICATION PANEL

- A. SmartRescue Base Stations:

1. Provide Rath model 2500-205FM with battery backup model RP7300109A for up to 5 call boxes.
 2. Provide Rath Model 2500-210FM with battery backup model RP7300109A for 6-10 call boxes.
 3. Provide model as required for the call stations shown on the drawings with emergency battery back-up at the main entrance unless otherwise noted on the drawings.
 4. In renovation projects, cut and patch wall as required to install panel recessed.
- B. Easy to use pushbuttons
- C. Passively monitor communications between Call Boxes and outside world via the LEDs:
1. Solid lit LED indicates there is an emergency call in progress.
 2. Slow blinking LED indicates there is a call on hold.
- D. Audible alert when Call Box initiates call, silenced when call is joined from Base Station.
- E. Includes relay contact that trips if any Call Box has been activated.
- F. The Base Station shall be able to:
1. Call into all or individual Call Boxes as needed.
 2. Join existing conversations between Call Boxes and outside world.
 3. Hang up and original conversation will continue.
 4. Terminate outside world so it is only talking to the Call Boxes or terminate the call with all parties entirely.
- G. Volume control handset meets ADA requirements.
- H. Designed for either 120-vac or 24-vdc power.
- I. Provide 16.8V 1400mAH battery model RP7300109A.
1. Built-in battery backup recharges from 120vac or 24vdc power (allows for a minimum of 4 hours talk time upon loss of power).
- J. Telephone Line Voltage: 24v-48v
- K. Meets all IBC, ADAAG, and NFPA code requirements.
- L. Conforms to UL Standard 2017 for Attendant Monitored Signaling Devices.
- M. Complies with Section 6.4 of UL 60950-1.

2.4 POWER SUPPLY

- A. Provide Rath SmartRescue System Power Supplies model 2500-PWR24U as required for the system components.
- B. Size: 8.78" H x 12.29" W x 2.81" D.
- C. Input: 100-120vac, 50/60Hz, 4.0A.

- D. Output:
 - 1. 24vdc @5A total continuous output.
 - 2. Filtered and electronically regulated output.
 - 3. 12 PTC protected outputs @0.500A current limited.
 - 4. Class 2
 - 5. 24vdc adjustable output.
 - 6. 24vdc S1 on/off switch.
 - 7. Input and output status LED indicators.
- E. Protection: Short Circuit/Overload/Over Voltage.
- F. Supervision: DC power failure supervision (form C contacts).
- G. Environmental:
 - 1. For indoor use ONLY.
 - 2. Operating temperature 32° F to 120° F ambient.

2.5 IP CELLULAR INTERFACE DEVICE

- A. Provide Rath IP Based Cellular Interface Device model 2100-VOIPLCCV.
- B. Dimensions: 11-1/2" H x 10" W x 5" D.
- C. Transmits both voice and data wirelessly.
- D. Setup a standard 4G cellular account with Verizon. Receive a 4G SIM card and install in the unit. Also, setup an account with Flow Route for the data transmission. The system will still be wireless.
- E. Allows for a RATH® Emergency Phone System to dial off-site wirelessly.
- F. The 2100-VOIPLCCV provides an "alarm" output that is triggered when the device has lost cellular connection for NFPA 72 Supervision Compliance.
- G. Requires a standard 15mm x 25mm SIM card.
- H. VoIP Protocols: SIP v2, SDP, RTP, and RFC 2833.
- I. Network Protocols: IPv4, TCP, UDP, DHCP, SNTP, STUN, HTTP, and PPPoE.
- J. Connections: FXS RJ11, LAN, and WAN RJ45 (10/100 BaseT).
- K. Power: 120vac.
- L. Power Consumption: 8w.
- M. Temperature Range: -14°F – 122°F.
- N. Wall mount enclosure with door.

- O. FCC Part 15 compliant

2.6 EMERGENCY COMMUNICATION REMOTE STATION

- A. SmartRescue System Call Boxes:
 - 1. Provide Rath Model 2100-958NSR with battery Model RP7300110 for new construction.
 - 2. Provide Rath Model 2100-956SR with battery Model RP7300110 for existing walls in renovation projects.
 - 3. Provide Rath Model 2100-984LRC1 with battery Model RP7300110 or exterior locations.
 - 4. Provide stations at all elevator lobbies shown on the Architectural/Electrical Drawings.
- B. Dimensions:
 - 1. 2100-958NSR – 9-1/2" H x 7-1/2" W
 - 2. 2100-956SR – 7-1/4" H x 4-3/4" W x 1-7/8" D.
 - 3. 2100-984LRC1 – 9-7/8" H x 6-5/8" W x 3-1/4" D.
- C. Meets all IBC, ADAAG, and NFPA code requirements.
- D. Power Requirements: 24vdc from power supply.
- E. Provide 7.2V 300mAH battery (Model RP7300110).
- F. Built-in battery backup recharges from 24vdc power.
 - 1. Allows for a minimum of 4 hours of talk time upon power loss.
- G. Built-in 10 phone consolidator feature allows you to install 10 Call Boxes and 1 Base Station on a single telephone line.
- H. Programmable with up to 5 emergency numbers
- I. On-site keypad programming or remote programming.
- J. Remote or on-site diagnostic test.
- K. Recordable location message: 18 seconds.
- L. Automatic dialer: 31-digit programmable memory.
- M. Phone checks every 24 hours for an active phone line, if one is not detected, phone will provide a relay trip.
- N. Compatible with SmartRescue Base Station or Command Center for in-building rescue coordination.
- O. Automatic answer feature with audible ring.
- P. Touch Tone operation only (Touch Tone is an AT&T registered trademark)
- Q. Conforms to UL Standard 2017 for Attendant Monitored Signaling Devices.

- R. Complies with Section 6.4 of UL 60950-1.

2.7 WIRING

- A. Communications Cabling: Rath CI 2-hour fire-rated cable Model RP6600300M.
- B. Power Cabling: Rath power cable Model RP7500094P.

2.8 EMERGENCY COMMUNICATION PANEL SIGNAGE

- A. Baked-Enamel Sign with building floorplan:
 - 1. Provide a preprinted aluminum sign, punched or drilled for fasteners, with colors, legend and size required for the application with 1/4" grommets in corners for mounting.
 - 2. Show building floor plan in dark ink.
 - 3. Each elevator landing shall be clearly indicated in red ink and correspond to the name for the area station on the panel.
 - 4. Instruction signage shall include black letters with silver background.
 - 5. Minimum Dimensions shall be 9" H x 12" W.

2.9 ELEVATOR LANDING SIGNAGE

- A. Instruction Sign:
 - 1. Provide Rath Model 7049SS at each remote station.
 - 2. Instruction signage shall include black letters with silver background.
 - 3. Signs shall have "peel and stick" mounting for easy installation.
 - 4. Dimensions shall be 8" H x 6" W.
- B. Illuminated Sign:
 - 1. Provide Rath Model 7050E or 7050ED at the entrance to the Elevator Area.
 - 2. The internally illuminated LED shall be 10.5" H x 14" W x 3" D.
 - 3. Sign must have red LED lights that provide constant uniform illumination.
 - 4. Sign must be UL listed to meet UL 924, NEC, OSHA, NFPA, and Life Safety Code Illumination requirements.
 - 5. Sign must also be provided with directional left and right arrows.
- C. Tactile Signage:
 - 1. Provide Rath Model 7087 at the entrance to the Elevator Area.
 - 2. Tactile signage shall be white letters with blue background.
 - 3. Signs shall have "peel and stick" mounting for easy installation.
 - 4. Signs shall also include raised letters and Braille.
 - 5. Dimensions shall be 8" H x 6" W.
- D. Directional Signage
 - 1. Provide Rath Model 7047EL or 7047ER to direct to the Elevator Area.
 - 2. Tactile signage shall be white letters with blue background.
 - 3. Signs shall have "peel and stick" mounting for easy installation.
 - 4. Signs shall also include raised letters and Braille.

5. Dimensions shall be 4" H x 12" W.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with installation instructions provided by system manufacturer.
- B. System shall be in compliance with all state and local electrical codes.
- C. Provide 1P.20A breaker in nearest 120/208V normal/emergency panelboard and connect to emergency communications panel/battery backup, power supply, and IP cellular interface/VOIP interface device with 2#10 + 1#10 gnd in 3/4" conduit unless otherwise noted.
- D. Provide Rath CI 2-hour fire-rated cable between panel and remote stations for communications.
- E. Provide Rath power cable between power supply and panel/remote stations for power.
- F. Install system to comply with drawings and final shop drawings in compliance with manufacturer's printed instructions and the project plans.
- G. Cable identification shall be provided on both ends of each cable and termination with the Owners room number and the wiring block or device to which it is connected. Tags shall be permanent and neat.
- H. Furnish and install necessary wire to provide a complete system or systems as herein specified. All wiring shall be tested for continuity and freedom of all grounds and short circuits.
- I. Provide Category 6 cable per Division 27 in 3/4" conduit from nearest MDF/IDF rack to emergency communication panel with terminations on both ends.
- J. In renovation projects, cut and patch wall as required to install emergency communication panel recessed.

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 wiring from equipment 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 MOUNTING HEIGHTS

- A. Emergency Communication Panel: Mount at 60" from floor to center of cabinet. Verify with local code official.
- B. Emergency Communication Remote Station: Mount at 48" from floor to push button. Verify with local code official.
- C. Instruction Sign:
 - 1. Mount above or adjacent to each Call Box.
 - 2. Mount between 48" from floor to lowest tactile characters. Verify with local code official.
- D. Illuminated Sign:
 - 1. 120/277vac powered. Connect to local exit sign circuit with 2#12 + 1#12 gnd in 3/4" conduit.
 - 2. Mount above 60" but below 80" from the floor to top of the sign. Verify with local code official.
- E. Tactile Signage: Mount 48"-60" floor to lowest tactile character. Verify with local code official.
- F. Directional Signs:
 - 1. Mount 48" from the floor to the bottom of the sign. Verify with local code official.
 - 2. Located in hallway adjacent to Emergency Communication Remote Station.

3.4 FIELD QUALITY CONTROL

- A. Site Tests (Post Installation Testing):
 - 1. Checkout final connections to the system shall be made by a factory technician authorized by the manufacturer of the products installed.
 - 2. Factory authorized technicians shall demonstrate operation of the complete system and each major component to the staff.
 - 3. System field wiring diagrams shall be provided to the subcontractor by the manufacturer prior to installation.
- B. Inspection: Perform a complete functional test of the system upon completion of the installation and instruct the staff in the operation and maintenance of the system.
- C. Cleaning:
 - 1. Repair or replace damaged installed products.
 - 2. Remove construction debris from project site and legally dispose of debris.

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 1-hour session to demonstrate system.
3. Provide documentation of sessions to Architect/Engineer with signatures of at least 3 Owners Representatives present at demonstration.

END OF SECTION 283220

SECTION 285000 – IN-BUILDING TWO-WAY EMERGENCY RESPONDER COMMUNICATION ENHANCEMENT SYSTEM

PART 1 - GENERAL

1.1 REFERENCES

- A. International Building Code (IBC)
- B. International Fire Code (IFC)
- C. NFPA 70 - National Electric Code (NEC) as adopted by IBC
- D. NFPA 72 – National Fire Alarm Code (NFC) as adopted by IBC
- E. NFPA 101 – Life Safety Code (LSC)
- F. NFPA 1 – Fire Prevention Code (FPC)
- G. NFPA 72 – National Fire And Signaling Code
- H. NFPA 1221 – Standard for Installation, Maintenance, and Use of Emergency Services Communications Systems
- I. UL 2524 – Standard for In-building 2-way Emergency Radio Communication Enhancement System, 2nd Edition

1.2 SYSTEM DESCRIPTION

- A. The In-Building Two-Way Emergency Responder Communication Enhancement System work shall include pathways, signal boosters (bi-directional amplifiers), antennas, couplers, connectors, power splitters, coaxial/fiber cable and other components and interconnecting circuitry as required for a fully functional system.
- B. The system shall comply with the requirements of UL2524 2nd Edition Standard for In-building 2-Way Emergency Radio Communication Enhancement Systems, NFPA 72 2013 Edition, NFPA 1221 2016 Edition and IFC 2018 or later, as referenced.
- C. The entire system shall meet the requirements of the Fire Department, the Building Department and all other agencies and authorities having jurisdiction (AHJ).
- D. The work in this section shall include the responsibility for all permit requirements with the AHJ. Where filings require engineer's signature, documents shall be submitted for his review and signature. This responsibility shall include furnishing of required quantities of floor plans, descriptive notes and/or specifications, wiring diagrams, shop drawings and amendment forms.

- E. Early completion of the in-building two-way emergency responder communication enhancement system will be required as to permit a Certificate of Occupancy to be obtained in a timely manner.
- F. Any permits necessary for the installation of the work shall be obtained prior to the commencement of the work. All permit costs and inspection fees shall be included in Base Bid.
- G. The in-building two-way emergency responder communication enhancement system shall use a signal booster with a UL2524 2nd edition listing from an Occupational Safety and Health Administration (OSHA) approved Nationally Recognized Testing Laboratory (NRTL), NFPA 72, NFPA 1221 and IFC 2018 or later compliance.

1.3 DESIGN REQUIREMENTS

- A. In-building two-way emergency responder communication enhancement systems for emergency responders are an integral component of the life safety equipment of a building or structure. The primary function is to provide reliable emergency responder communications at the required signal strength within the specified areas.
- B. Critical Areas such as emergency command center, fire pump room, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations and similar critical areas as specified by AHJ shall be provided with 99% floor area radio coverage.
- C. General building areas shall be provided with 95% radio coverage, or as specified by AHJ.
- D. The In-building two-way emergency responder communication enhancement system must provide the following signal strengths:
 - 1. Minimum DAQ of 3.0 or better and equivalent signal to interference noise ratio (SINR) applicable to the technology for either analog or digital.
 - 2. Downlink - Minimum signal strength of -95 dBm throughout the coverage area.
 - 3. Uplink - Minimum signal strength of -95 dBm received at the AHJ Radio System
- E. The system shall be complete with all components and wiring required for compliance with all applicable codes and regulations, and for its operations described hereinafter.
- F. An approved manufacturer or a qualified and approved vendor shall supply, test and determine locations of components which are required for proper operation as well as to supply, install, test and certify the performance of the complete system. Vendor qualifications must be acceptable to the AHJ.
- G. Design shall include iBwave software-simulated radio propagation modeling with heat maps showing predicted signal coverage levels within the building. The iBwave design shall be done by iBwave level 2 or higher certified personnel.
- H. All tests shall be conducted, documented, and signed by a person in possession of an FCC General Radio Telephone Operators License. All testing personnel shall be certified and authorized by the signal booster manufacturer in the installation and operation of their equipment. Personnel qualifications must be acceptable to the AHJ.

- I. The system design shall be based on the NOTIFIER line of Public Safety Signal Boosters / Fiber DAS or equivalent UL2524 2nd Edition, NFPA 72, NFPA 1221, IFC and FCC certified to establish standards of quality for materials and performance. The naming of a specific manufacturer or a catalog number does not waive any requirement or performance of individual components described in the specifications.
- J. Assembly and installation of all components of the In-building Two-way Emergency Responder Communication Enhancement System shall comply with all applicable sections of the National Electrical Code.
- K. Survivability from attack by fire shall meet requirements of NFPA 72, NFPA 1221, IFC or as required by the local jurisdiction.
- L. The system must comply with all applicable sections of the FCC rules. Signal booster / Fiber DAS Master/Remote shall have FCC certification prior to installation.
- M. Antenna isolation shall be maintained between the donor antenna and all inside antennas (DAS) to a minimum of 20dB under all operating conditions.

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. 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. Coaxial and Fiber Cable
 - e. 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 system device locations shown
 - d. Typical device connections for each type device used in the system
 - e. Basic riser diagram to include control equipment and all field circuits
- 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.

1.5 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. Operating and Instruction Manuals of the entire system.
- E. Copy of the Testing and Maintenance Agreement for the first year of service.

1.6 QUALIFICATIONS

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

1.7 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS AND OPERATIONS

2.1 MANUFACTURER

- A. The system design shall be based on the NOTIFIER line of Public Safety Signal Boosters / Fiber DAS or equivalent UL2524 2nd Edition, NFPA 72, NFPA 1221, IFC and FCC certified to establish standards of quality for materials and performance. The naming of a specific manufacturer or a catalog number does not waive any requirement or performance of individual components described in the specifications.

2.2 TECHNICAL SPECIFICATIONS AND PERFORMANCE REQUIREMENTS

- A. The system specified shall meet the requirements of Public Safety UL2524 2nd Edition, NFPA72, NFPA 1221, IFC compliant signal boosters / Fiber DAS Master/Remote.
- B. The system shall be Public Safety type with Class A or Class B signal booster or Fiber DAS Master/Remote, as designated by the FCC or as required by the AHJ.

- C. The secondary power supplies, battery chargers and system monitoring shall be fully compliant with UL2524 2nd Edition, NFPA 72, NFPA 1221 and IFC. The signal booster shall have both the primary and the secondary power supplies within a waterproof, type-4 approved enclosure.
- D. Signal Boosters:
1. All signal boosters and other active system components must have FCC certification prior to installation. The equipment FCC ID must be displayed on the product as required by the FCC.
 2. The digital signal booster shall be capable of field configuration via programmable software for the frequency channels with adjustable bandwidths as specified by the AHJ.
 3. 700MHz & 800MHz + FirstNet Band 14, VHF, UHF signal boosters shall support both Class A and Class B operation. Signal boosters shall be channel selective type with 150KHz, 100KHz, 75KHz, 62.5KHz, 50KHz, 37.5KHz, 25KHz, and 12.5KHz. channel bandwidth options. Non-selective wide-band signal boosters shall not be accepted, unless required to cover multiple channels within the same band.
 4. Signal Boosters shall have oscillation suppression circuitry to protect the public safety radio system in case of system malfunction or other causes. This signal booster circuitry shall allow real time automated oscillation correction and immediate detection capable of generating an oscillation alarm, combined with programmable limited operation or auto-shutdown if performance migration fails.
 5. Signal Boosters must have uplink noise suppression function to eliminate uplink noise while in standby (i.e. no radio transmission from within a building). Systems that produce any measurable level of uplink noise while in standby shall not be acceptable.
 6. Signal booster must have uplink, and downlink squelch per channel per timeslot.
 7. Signal Booster gain shall be rated at minimum of 85dB +/- 2.0dB and the gain shall be adjustable in a minimum of 28dB range. System gain shall be set and documented at the time of the final system test.
 8. Maximum propagation delay of the signal booster system shall be adjustable in the signal booster to comply with system requirement or as specified by the AHJ. Signal booster shall offer filter delay options. Maximum propagation delay shall be within the minimum Range of 3.5μS (microseconds) to a maximum of 61.5μS (microseconds).
 9. Signal Booster shall produce no more than a maximum of 9dB noise throughout its published operable uplink gain range.
 10. The signal booster system shall include built-in automatic supervision of malfunctions of the signal booster and battery systems as per NFPA 1221, NFPA 72 and IFC. Non-OEM equipment add-ons and modifications to comply with this specification shall not be acceptable.
 11. Signal booster shall meet Buy American compliance requirements
- E. A dedicated supervised monitoring/annunciator panel shall be provided within the emergency command center next to the fire alarm panel / annunciator or other location as designated by AHJ to annunciate the status of all signal booster locations. The monitoring panel shall provide visual and labeled indication of the following for each signal booster:
1. Normal AC power
 2. Signal booster trouble
 3. Antenna Failure
 4. Loss of normal AC power
 5. Failure of battery charger

6. Low battery capacity
7. Active System component failure

- F. If signal booster is supervised by a NOTIFIER fire alarm panel, the signal booster system shall include a compatible, OEM built-in NOTIFIER addressable monitoring module. If signal booster is supervised by other brand FACP, the signal booster system shall be Honeywell branded model with universal normally open relays for connection to external monitoring modules.
- G. External filters, duplexers, power supplies or other non-OEM additions or modifications of the original equipment shall not be acceptable with the exception where technically required so long as it does not violate the UL2524 2nd edition certification. If required, the external filters should be manufactured or certified by the manufacturer.
- H. All signal booster components shall be contained in a type-4 approved waterproof enclosure. All enclosures shall be painted red with external labeling as required by the AHJ.

2.3 RF COAXIAL CABLE

- A. RF Coaxial Cable shall be a listed, CMP plenum or armored plenum coaxial cable or 2-hour fire rated plenum coaxial cable. Non-plenum cable can be used when installed in a metallic raceway. The cable classification shall be clearly marked on the outer surface of the cable regular intervals.

2.4 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 In-building Two-way Emergency Responder Communication System panels, signal boosters and power supplies.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation of all components of the In-building Two-way Emergency Responder Communication Enhancement System shall comply with all applicable sections of the National Electrical Code NFPA-70, NFPA-72, NFPA 1221, IFC or as required by the local AHJ.
- B. At least 2 independent and reliable power supplies shall be provided as specified in NFPA 72, NFPA 1221 and IFC.
- C. The primary power source shall be supplied from a dedicated twenty (20) ampere branch circuit and comply with NFPA-70 National Electrical Code, NFPA 72 and NFPA 1221 2016 edition.
- D. The signal booster shall be equipped with a secondary source of power. The secondary source of power shall be a battery system with a dedicated battery charger powered by a separate, dedicated twenty (20) ampere branch circuit. The secondary power supply shall power on automatically when the primary power source is lost. The secondary source of power shall be capable of operating the in-building two-way emergency responder communication enhancement system for a period of at least 24 hours. The battery system shall automatically charge in the presence of external power input. Battery charger and all other electronic components must be fully enclosed in a waterproof Type-4 approved enclosure. Batteries shall be enclosed in a NEMA-4 rated enclosure. External UPS (Uninterruptable Power Supplies) are not acceptable.
- E. All installed systems will need prior written approval from the FCC license holder of the systems being re-amplified and must meet their established criteria for installation prior to the system installation.
- F. Installed systems shall be registered with the FCC signal booster registry where required.
- G. Provide circuit breaker lockout for all circuit breakers feeding in-building two-way emergency responder communication enhancement system equipment.

3.2 FIELD QUALITY CONTROL

- A. Acceptance testing for an in-building two-way emergency responder communication enhancement system is required upon completion of installation.
- B. The coverage testing shall be done in accordance with NFPA 72, NFPA 1221, IFC and as required by the local AHJ
- C. All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radio Operator License.

- D. All test records along with system diagrams, iBwave design, equipment specifications, user manuals, RF link budget calculations, battery backup calculation and other design data shall be submitted upon completion of the project, and as required by the AHJ.

3.3 TRAINING

- A. Personnel Training: Provide and pay for the services of a factory-authorized service representative to demonstrate the system and train Owner's 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.

END OF SECTION 285000