

The Solanco School District New District Administrative Offices & Athletic Fields

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

CRA PROJECT NO. 3706

CONFORMED SET - July 8, 2026



CONFORMED SPECIFICATIONS

THE FOLLOWING SPECIFICATIONS HAVE BEEN REVISED TO INCLUDE ADDENDA ITEMS. SPECIFICATIONS SETS ARE BEING ISSUED AS A CONVENIENCE TO ALL PARTIES INVOLVED IN ORDER TO EXPEDITE THE COORDINATION AND CONSTRUCTION OF THIS PROJECT. THESE SPECIFICATIONS ARE NOT CONTRACT DOCUMENTS. IF ANY CONFLICTS OR DISCREPANCIES ARISE BETWEEN THESE DOCUMENTS AND THE ORIGINAL CONTRACT DOCUMENTS AND ADDENDA; THE ORIGINAL CONTRACT DOCUMENTS AND ADDENDA TAKE PRECEDENCE.

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VOLUME 3

TECHNICAL SPECIFICATIONS

FOR

**NEW DISTRICT ADMINISTRATIVE
OFFICES & ATHLETIC FIELDS**

FOR THE

THE SOLANCO SCHOOL DISTRICT

121 South Hess Street

Quarryville, PA 17566



**CRABTREE, ROHRBAUGH & ASSOCIATES
ARCHITECTS**

401 East Winding Hill Road
Mechanicsburg, Pennsylvania 17055

ARCHITECT'S PROJECT NO. 3706

TABLE OF CONTENTS
VOLUME 1 - PROJECT MANUAL

BIDDING REQUIREMENTS, CONTRACT FORMS AND CONDITIONS OF THE CONTRACT

SECTION 000005	COPYRIGHT
SECTION 000010	ADVERTISEMENT FOR BIDS (ADDENDUM 3)
SECTION 000100	INSTRUCTIONS TO BIDDERS (AIA DOCUMENT A701-2018)
SECTION 000101	SUPPLEMENTARY INSTRUCTIONS TO BIDDERS
SECTION 000301	BID FORM - CONTRACT 3706-1 GENERAL CONSTRUCTION (ADDENDUM 5)
SECTION 000302	BID FORM - CONTRACT 3706-2 SITE CONSTRUCTION (ADDENDUM 5)
SECTION 000303	BID FORM - CONTRACT 3706-3 HVAC CONSTRUCTION (ADDENDUM 5)
SECTION 000304	BID FORM - CONTRACT 3706-4 PLUMBING CONSTRUCTION (ADDENDUM 5)
SECTION 000305	BID FORM - CONTRACT 3706-5 ELECTRICAL CONSTRUCTION (ADDENDUM 5)
SECTION 000420	CONTRACTOR'S QUALIFICATION STATEMENT (AIA DOCUMENT A305)
SECTION 000429	NON-COLLUSION AFFIDAVIT OF CONTRACTOR
SECTION 000460	NON-DISCRIMINATION AFFIDAVIT
SECTION 000500	STANDARD FORM OF AGREEMENT BETWEEN OWNER & CONTRACTOR (STIPULATED SUM) (AIA DOCUMENT A101-2017)
SECTION 000510	PUBLIC SCHOOL CODE AGREEMENT
SECTION 000515	EMPLOYMENT VERIFICATION ACT
SECTION 000520	AFFIDAVIT ACCEPTING PROVISIONS OF THE WORKMAN'S COMPENSATION ACTS
SECTION 000550	BID BOND (AIA DOCUMENT A310)
SECTION 000600	PERFORMANCE & PAYMENT BONDS
SECTION 000700	GENERAL CONDITIONS OF CONTRACT FOR CONSTRUCTION (AIA DOCUMENT A201-2017)
SECTION 000750	SUPPLEMENTARY GENERAL CONDITIONS
SECTION 000800	SPECIAL CONDITIONS FOR EDUCATIONAL PROJECTS
SECTION 000860	PA TAX EXEMPT ENTITIES DISCLOSURE
SECTION 000900	PREVAILING MINIMUM WAGE PRE-DETERMINATION
SECTION 000910	PREVAILING WAGE RATES
SECTION 000920	GEOTECHNICAL REPORT (ADDENDUM 4)

DIVISION 1 – GENERAL REQUIREMENTS

SECTION 011000	SUMMARY OF WORK (ADDENDUM 5)
SECTION 012200	UNIT PRICES
SECTION 012300	ALTERNATES (ADDENDUM 5)
SECTION 012500	SUBSTITUTIONS
SECTION 012600	MODIFICATION PROCEDURES
SECTION 012700	CUTTING AND PATCHING
SECTION 012800	FIELD ENGINEERING
SECTION 012900	APPLICATIONS FOR PAYMENT
SECTION 013100	PROJECT COORDINATION
SECTION 013150	PROJECT MEETINGS
SECTION 013200	CONSTRUCTION PROGRESS DOCUMENTATION
SECTION 013300	SUBMITTALS
SECTION 014000	QUALITY REQUIREMENTS
SECTION 014100	SAFETY

SECTION 015000	TEMPORARY FACILITIES & CONTROLS
SECTION 017200	PROJECT RECORD DOCUMENTS
SECTION 017700	CONTRACT CLOSEOUT
SECTION 017800	FINAL CLEANING
SECTION 017823	OPERATION & MAINTENANCE DATA
SECTION 017900	WARRANTIES

TABLE OF CONTENTS
VOLUME 2 - TECHNICAL MANUAL

DIVISION 3 – CONCRETE

SECTION 033000 CAST IN PLACE CONCRETE

DIVISION 4 - MASONRY

SECTION 042000 UNIT MASONRY (ADDENDUM 5)

SECTION 047200 CAST STONE MASONRY

DIVISION 5 - METALS

SECTION 051200 STRUCTURAL STEEL FRAMING

SECTION 052100 STEEL JOIST FRAMING

SECTION 053100 STEEL DECKING

SECTION 054000 COLD-FORMED METAL FRAMING (ADDENDUM 5)

SECTION 055000 METAL FABRICATIONS (ADDENDUM 5)

SECTION 055100 METAL STAIRS

SECTION 055213 PIPE AND TUBE RAILINGS (ADDENDUM 5)

DIVISION 6 – WOOD, PLASTICS AND COMPOSITES

SECTION 061000 ROUGH CARPENTRY

SECTION 061600 SHEATHING

SECTION 064023 INTERIOR ARCHITECTURAL WOODWORK

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

SECTION 071110 COMPOSITE SHEET WATERPOOFING

SECTION 072100 THERMAL INSULATION

SECTION 072500 WEATHER BARRIERS

SECTION 074113 STANDING SEAM METAL ROOF PANELS (ADDENDUM 5)

SECTION 074214 METAL SOFFIT PANELS

SECTION 074223 METAL WALL PANELS (ADDENDUM 5)

SECTION 074243 COMPOSITE METAL PANELS

SECTION 075323 ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

SECTION 075416 Ketone Ethylene Ester (KEE) Roofing (ADDENDUM 4)

SECTION 076200 SHEET METAL FLASHING AND TRIM

SECTION 077200 ROOF ACCESSORIES (ADDENDUM 4)

SECTION 078413 PENETRATION FIRESTOPPING

SECTION 079200 JOINT SEALANTS

SECTION 079500 EXPANSION CONTROL

DIVISION 8 - OPENINGS

SECTION 081113 HOLLOW METAL DOORS AND FRAMES

SECTION 081416 FLUSH WOOD DOORS

SECTION 083300 OVERHEAD COILING DOORS AND GRILLES (ADDENDUM 4)

SECTION 084113 ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

SECTION 085820 MISCELLANEOUS WINDOWS AND ACCESSORIES

SECTION 087100 DOOR HARDWARE

SECTION 088000	GENERAL GLAZING
SECTION 088100	FIRE-RATED GLAZING
SECTION 088723	SAFETY & SECURITY WINDOW FILM
SECTION 088810	FIRE-RATED FRAMES AND GLAZING
SECTION 088853	SECURITY GLAZING

DIVISION 9 - FINISHES

SECTION 092216	NON-STRUCTURAL METAL FRAMING
SECTION 092900	GYPSUM BOARD
SECTION 093000	TILING
SECTION 095113	ACOUSTICAL PANEL CEILINGS
SECTION 095421	LINEAR METAL CEILINGS
SECTION 096513	RESILIENT BASE AND ACCESSORIES
SECTION 096519	RESILIENT TILE FLOORING
SECTION 096723	RESINOUS FLOORING
SECTION 096813	TILE CARPETING
SECTION 097200	WALLCOVERINGS
SECTION 099123	PAINTING
SECTION 099600	HIGH PERFORMANCE COATINGS

DIVISION 10 - SPECIALTIES

SECTION 101100	VISUAL DISPLAY UNITS
SECTION 101112	SPECIALTY BUILDING PRODUCTS
SECTION 101115	VINYL GRAPHICS
SECTION 101419	DIMENSIONAL LETTER SIGNAGE (ADDENDUM 4)
SECTION 101423	PANEL SIGNS
SECTION 102113	TOILET COMPARTMENTS
SECTION 102800	TOILET AND BATH ACCESSORIES (ADDENDUM 4)
SECTION 104413	FIRE EXTINGUISHER CABINETS
SECTION 104416	FIRE EXTINGUISHERS
SECTION 105000	METAL LOCKERS (ADDENDUM 4)
SECTION 107300	ALUMINUM CANOPY (ADDENDUM 5)

DIVISION 12 - FURNISHINGS

SECTION 122413	ROLLER WINDOW SHADES
SECTION 123661	SIMULATED STONE FABRICATIONS

TABLE OF CONTENTS
VOLUME 3 – TECHNICAL SPECIFICATIONS

DIVISION 22 – PLUMBING

SECTION 220010	PLUMBING GENERAL PROVISIONS
SECTION 220100	PLUMBING GENERAL EQUIPMENT
SECTION 220250	PLUMBING INSULATION
SECTION 220410	PLUMBING PIPING & SPECIALTIES (ADDENDUM 5)
SECTION 220440	PLUMBING FIXTURES & EQUIPMENT (ADDENDUM 5)
SECTION 220800	PLUMBING COMMISSIONING

DIVISION 23 – MECHANICAL

SECTION 230010	MECHANICAL GENERAL PROVISIONS
SECTION 230100	MECHANICAL GENERAL EQUIPMENT
SECTION 230250	HVAC INSULATION
SECTION 230510	HVAC PIPING & SPECIALTIES
SECTION 230540	HVAC PUMPS (ADDENDUM 1)
SECTION 230545	CHEMICAL WATER TREATMENT (ADDENDUM 1)
SECTION 230570	BOILERS & BURNERS
SECTION 230800	HVAC COMMISSIONING
SECTION 230835	HVAC EQUIPMENT
SECTION 230855	AIR HANDLING UNITS
SECTION 230860	VENTILATION EQUIPMENT
SECTION 230890	DUCTWORK SYSTEMS
SECTION 230900	ATC SYSTEMS (ADDENDUM 1)
SECTION 230990	TESTING, ADJUSTING, AND BALANCING

DIVISION 26 - ELECTRICAL

SECTION 260010	ELECTRICAL GENERAL REQUIREMENTS
SECTION 260180	EQUIPMENT WIRING SYSTEMS
SECTION 260519	ELECTRICAL POWER CONDUCTORS AND CABLES
SECTION 260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
SECTION 260529	HANGERS AND SUPPORTS
SECTION 260533	RACEWAYS AND BOXES
SECTION 260543	UNDERGROUND DUCTS AND RACEWAYS
SECTION 260544	SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
SECTION 260553	IDENTIFICATION
SECTION 260573	OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
SECTION 260583	UTILITY SERVICE ENTRANCE
SECTION 260620	SCHEDULES FOR ELECTRIC DISTRIBUTION EQUIPMENT (ADDENDUM 5)
SECTION 260650	LUMINAIRE SCHEDULE (ADDENDUM 5)
SECTION 260800	ELECTRICAL SYSTEMS COMMISSIONING
SECTION 260940	DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM
SECTION 262200	LOW VOLTAGE TRANSFORMERS
SECTION 262300	MINI-POWER ZONES
SECTION 262416	PANELBOARDS
SECTION 262726	WIRING DEVICES

SECTION 262730	FLOOR BOXES AND POKE-THRU'S
SECTION 262813	FUSES
SECTION 262816	ENCLOSED SWITCHES AND CIRCUIT BREAKERS
SECTION 262830	ENCLOSED CONTACTORS
SECTION 262900	ELECTRIC CONTROLS, PUSHBUTTONS, RELAYS AND EQUIPMENT
SECTION 262913	ENCLOSED CONTROLLERS
SECTION 263213	ENGINE GENERATORS
SECTION 263600	AUTOMATIC TRANSFER SWITCHES
SECTION 263604	NON-AUTOMATIC TRANSFER SWITCHES
SECTION 264313	DISTRIBUTION SURGE PROTECTIVE DEVICES (ADDENDUM 5)
SECTION 265100	INTERIOR LIGHTING
SECTION 265600	EXTERIOR ILLUMINATED SECURITY BOLLARDS
SECTION 265669	EXTERIOR ATHLETIC LIGHTING (ADDENDUM 5)

DIVISION 27 - COMMUNICATIONS

SECTION 270500	COMMON WORK REQUIRED FOR COMMUNICATIONS
SECTION 271100	COMMUNICATIONS EQUIPMENT ROOM FITTINGS
SECTION 271300	COMMUNICATIONS BACKBONE CABLING
SECTION 271500	COMMUNICATION HORIZONTAL CABLING – CATEGORY 6
SECTION 271501	COMMUNICATIONS HORIZONTAL CABLING – CATEGORY 6A
SECTION 277000	LOCAL AUDIO VISUAL REINFORCEMENT SYSTEMS (ADDENDUM 5)
SECTION 278000	AUDIO-VISUAL SUPPORT EQUIPMENT (ADDENDUM 5)

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

SECTION 280500	COMMON WORK REQUIRED FOR ELECTRONIC SAFETY & SECURITY
SECTION 282300	VIDEO SURVEILLANCE SYSTEM CABLING
SECTION 282400	CAMERA-INTERCOM SYSTEM
SECTION 283111	DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM (ADDENDUM 5)
SECTION 283211	AREA OF RESCUE ASSISTANCE SYSTEM

DIVISION 31 – EARTHWORK

SECTION 310050	BASIC METHODS AND MATERIALS (ADDENDUM 3)
SECTION 311000	SITE CLEARING
SECTION 312000	EARTH MOVING (ADDENDUM 5)

DIVISION 32 – EXTERIOR IMPROVEMENTS

SECTION 321216	ASPHALT PAVEMENT
SECTION 321313	CONCRETE PAVEMENT
SECTION 321723	PAVEMENT MARKINGS
SECTION 321813	SYNTHETIC TURF ATHLETIC FIELD (ADDENDUM 3)
SECTION 323113	CHAIN LINK FENCES AND GATES (ADDENDUM 3)
SECTION 323300	SITE FURNISHING
SECTION 325000	MISCELLANEOUS SITE IMPROVEMENT (ADDENDUM 3)
SECTION 329200	TURF AND GRASSES
SECTION 329300	PLANTS

DIVISION 33 – UTILITIES

SECTION 331000 WATER UTILITIES (ADDENDUM 3)

SECTION 333000 SANITARY SEWERAGE UTILITIES (ADDENDUM 5)

SECTION 334000 STORM DRAINAGE UTILITY

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 01 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. Plumbing Fixtures and Equipment
 - 2. Sanitary Waste, Vent, and Domestic Water Piping
 - 3. Storm Water Piping System
 - 4. Condensate Drainage System
 - 5. Natural Gas Piping System
 - 6. Demolition

1.3 DEFINITION OF WORK RESPONSIBILITY

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

1.4 RULES AND REGULATIONS

- A. All work shall be performed in accordance with the current adopted rules and regulations of authorities having jurisdiction of the local plumbing codes, the utilities having jurisdiction, 2018 International Plumbing Code, 2018 International Building Code, 2018 International Mechanical Code, NFPA Code, PA Uniform Plumbing Code, 2018 International Fire Code, and 2018 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 Education, and all codes and agencies having jurisdiction.
- C. All construction, design fabrication, tests, rating, and installation shall comply with the rules and regulations of all local, state, or national codes and agencies having jurisdiction over this project. Any costs involved in complying with these rules and regulations shall be included in original bid of this Contractor.
- D. This Contractor shall obtain and pay for all construction and installation permits, certificates, and inspection fees relative to his work. He shall also prepare all specific plans as required by proper authorities before acceptance of the work. Costs incurred in the preparation of such plans shall be included in the Contractor's original bid.

1.5 DRAWINGS

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

1.6 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT, AND MATERIALS

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

1.7 COORDINATION OF WORK

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

1.8 LOCATION OF EQUIPMENT

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

1.9 MATERIALS AND EQUIPMENT

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

1.10 WORKMANSHIP

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

1.11 PROTECTION OF EQUIPMENT

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

1.12 SCAFFOLDING AND HOISTING

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

1.13 FOREMAN

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

1.14 EXCAVATION AND BACKFILL

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

1.15 PAINTING

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

1.16 CUTTING AND PATCHING

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

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.

1.17 WORK SEQUENCE

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

1.18 CLEANING

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

1.19 OPERATING AND MAINTENANCE INSTRUCTIONS

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

1.20 CLEANING AND FINISHING

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

1.21 INSTRUCTION OF EMPLOYEES

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

1.22 GUARANTEE

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

1.23 DESCRIPTION OF BASE BID AND ALTERNATE BIDS

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

1.24 DESCRIPTION OF UNIT PRICES (PLUMBING)

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

PART 2 - EXECUTION

2.1 INSTALLATION

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

2.2 PIPING INSTALLATION

- A. In general, piping shall be exposed in equipment rooms, and concealed in all finished rooms. Where piping is exposed, it shall be run 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 airtight with a non-combustible inorganic material.

2.4 UNIONS

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

2.5 CLEARANCE

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

2.6 INCREASES AT ROOF

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

2.7 SHOCK ABSORBERS

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

2.8 ESCUTCHEON PLATES

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

2.9 ACCESS PANELS

- A. Removable panels shall be located 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.

2.10 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.

2.11 PIPING UNDER FLOORS

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

2.12 INSERTS

- A. Except as noted, provide box type inserts for all hangers and supports intended to suspend piping or light weight equipment from new concrete construction. Fasten all inserts to the form work before concrete is poured. Inserts to be Grinnell Figure No. 282 or Figure No. 279 depending upon the maximum load to be carried.

- B. No toggle bolts, expansion screw anchors or similar imbedded hanger supports shall be used in new construction.

2.13 CHASES AND OPENINGS IN FLOORS AND WALLS

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

2.14 LUBRICATION

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

2.15 JOINTS AND CONNECTIONS

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

END OF SECTION 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. NEMA MG 1 - Motors and Generators.
- J. NFPA 70 - National Electrical Code.
- K. 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" travel.

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. 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%

2.6 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 (1) 2-1/2" diameter pressure gauges, 1-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. **This applies to all sleeves required for detail 5 on drawing S1.6. (Addendum 6).**
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Sleeves for Rectangular Ductwork: Galvanized steel.
- E. Firestopping Insulation: Glass fiber type, non-combustible.
- F. Sealant: Acrylic.

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.
- C. Plastic Engraved Ceiling grid tags shall be provided to indicate access point for service location for shutoff valves, balancing valves, and other equipment above ceilings. Tags shall be engraved with equipment tag or identifying valve tag.

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 wraparound 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. Piping Expansion Compensation:

1. Install in accordance with manufacturer's instructions.
2. Construct spool pieces to exact size of flexible connection for future insertion.
3. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
4. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
5. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
6. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where indicated.
7. Provide expansion loops as indicated on drawings.

B. Gauges and Meters:

1. Install positive displacement meters with isolating valves on inlet and outlet. Provide full line size valved bypass with globe valve for liquid service meters.
2. Install pressure gauges with pulsation dampers. Provide needle valve to isolate each gauge. Extend nipples to allow clearance from insulation.
3. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
4. Install thermometers in air duct systems on flanges.
5. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
6. Locate duct mounted thermometers minimum 10' downstream of mixing dampers, coils, or other devices causing air turbulence.
7. Coil and conceal excess capillary on remote element instruments.
8. Provide instruments with scale ranges selected according to service with largest appropriate scale.
9. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45° off vertical.
10. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
11. Locate test plugs adjacent thermometers and thermometer sockets, pressure gauges and pressure gauge taps, and where indicated.

C. Mechanical Identification:

1. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
2. Install tags with corrosion resistant chain.

3. Apply stencil painting in accordance with industry standards.
4. Install plastic pipe markers in accordance with manufacturer's instructions.
5. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
6. Install underground plastic pipe markers 6 to 8" below finished grade, directly above buried pipe.
7. Identify air handling units, heat pump, pumps, heat transfer equipment, tanks, and water treatment devices with stencil painting. Small devices, such as in-line pumps, may be identified with tags.
8. Identify control panels and major control components outside panels with plastic nameplates.
9. Identify thermostats relating to terminal boxes or valves with nameplates.
10. Identify valves in main and branch piping with tags.
11. Identify air terminal units and radiator valves with numbered tags.
12. Tag automatic controls, instruments, and relays. Key to control schematic.
13. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4" diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20' on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
14. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
15. Provide ceiling tags to locate valves or dampers above T-bar type panel ceilings. Locate on bottom of T-bar grille below equipment.
16. Provide Valve Identification Chart. Post framed chart in Boiler Room.

D. Vibration:

1. Install isolation for motor driven equipment.
2. Bases:
 - a. Set steel bases for 1" clearance between housekeeping pad and base.
 - b. Set concrete inertia bases for 2" clearance between housekeeping pad and base.
 - c. Adjust equipment level.
3. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim
4. Connect wiring to isolated equipment with flexible hanging loop.
5. All vibration isolation devices, including steel bases and pouring forms, shall be supplied by a single manufacturer.
6. All piping located in Mechanical Rooms or Boiler Rooms shall be isolated from the building structure by means of spring hangers.
7. Bases for all end suction pumps shall be sized to include supports for the suction and discharge elbows.
8. Flexible conduit shall be used for all electrical connections to isolated equipment. Flexible conduit shall be 50% longer than the actual distance between the rigid conduit and the equipment electrical connection locations.
9. The schedule of isolators required shall be as follows: Pumps - inertia bases, 2" (minimum) deflection springs.

10. Spring hangers for piping shall consist of clevis type hangers with spring hanger similar to Grinnell Fig. 247 or Fig. B-268 installed in threaded rod.
- E. Inserts:
1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4".
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- F. Pipe Hangers and Supports:
1. Support horizontal piping as scheduled.
 2. Install hangers to provide minimum 1/2" space between finished covering and adjacent work.
 3. Place hangers within 12" of each horizontal elbow.
 4. Use hangers with 1-1/2" minimum vertical adjustment.
 5. Support horizontal cast iron pipe adjacent to each hub, with 5' maximum spacing between hangers.
 6. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 8. Support riser piping independently of connected horizontal piping.
 9. Provide copper plated hangers and supports for copper piping.
 10. Design hangers for pipe movement without disengagement of supported pipe.
 11. Provide additional supports for heavy valves and specialties and provide sway bracing where needed.
 12. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 13. Insulation protection saddles shall be installed at all pipe hangers and supports for insulated lines. Saddles shall be rolled with a radius to suit the insulation O.D. Saddles shall be #16-ga galvanized steel and shall be 8" long.
- G. Equipment Bases and Supports:
1. Provide housekeeping pads of concrete, minimum 4" thick and extending 4 inches beyond supported equipment except pads in Boiler Room shall be 12" deep.
 2. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
 3. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
 4. Provide rigid anchors for pipes after vibration isolation components are installed.
- H. Flashing:
1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
 2. Flash vent and soil pipes projecting 3" minimum above finished roof surface with lead worked one 1" minimum into hub, 8" minimum clear on sides with 24" x 24" sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.

3. Flash floor drains in floors with topping over finished areas with lead, 10" clear on sides with minimum 36 x 36" sheet size. Fasten flashing to drain clamp device.
4. Seal floor, shower and mop sink drains watertight to adjacent materials.
5. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.
6. Provide curbs for mechanical roof installations 12" minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counter-flashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
7. Adjust storm collars tight to pipe with bolts caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

I. Sleeves:

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

3.2 MANUFACTURER'S FIELD SERVICES

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

3.3 SCHEDULES

- A. Supports and Hangers:

PIPE SIZE 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
1-1/2" – 2" C.I. Bell and Spigot (or No Hub) and at joints	5	15	3/8
3" C.I. Bell and Spigot (or No Hub) and at joints	5	15	1/2
4" - 5" C.I. Bell and Spigot (or No Hub) and at joints	5	15	5/8
6" - 8" C.I. Bell and Spigot (or No Hub) and at joints	5	15	3/4
10" – 12" C.I. Bell and Spigot (or No Hub) and at joints	5	15	7/8

B. Support horizontal piping within 12 inches of each fitting, valve, and coupling.

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

2.2 DOMESTIC WATER PIPING INSULATION

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

2.3 STORM AND CONDENSATE WATER PIPING

- A. All aboveground interior storm water (including roof drain bodies), including overflow storm drainage, and condensate pipes and fittings shall be insulated with nominal 1" wall thickness heavy density fiberglass insulation similar to Owens/Corning Fiberglass 24ASJ/SSL pipe insulation or equal with all service jacket, self-sealing lap and UL listed. Insulation shall have flame spread rating of 25 or less and a maximum smoke developed rating of 50 when tested by ASTM E-84 method.
- B. Optional pipe insulation shall be 1/2" 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. Provide PVC covers on all exposed piping and fittings in color selected by the architect. Covers in Gymnasium shall be 0.40 mil thick.
- 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. CW Pipe – 0.5" thick
 2. Hot Water/HW Recirc:
 - a. Up to 1-1/4" pipe size – 1.0"
 - b. 1-1/2" to 4" pipe size – 1.5"

END OF SECTION 220250

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
- I. ~~Natural~~ **Propane** Gas Piping Systems (**Addendum 5**)
- J. Condensate Piping Systems
- K. Water Hammer Arresters
- L. Backflow Preventers
- M. Interceptors
- N. Hose Bibbs
- O. Clay Traps
- P. Solenoid Valves
- Q. Washing Machine Boxes

1.2 REFERENCES

- A. ANSI B31.1 - Power Piping.
- B. ASME - Boiler and Pressure Vessel Code.
- C. ASME B16.3 - Malleable Iron Threaded Fittings.

- D. ASME B16.18 - Cast Bronze Solder-Joint Pressure Fittings.
- E. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings
- F. ASME B16.23 - Cast Copper Alloy Solder-Joint Drainage Fittings - DWV.
- G. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- H. ASTM A47 - Ferritic Malleable Iron Castings.
- I. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- J. ASTM A74 - Cast Iron Soil Pipe and Fittings.
- K. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses.
- 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: ASTM D2729 (if approved by local authority, Schedule 40, solid wall).
 - 1. Fittings: PVC
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
 - 3. Not allowed for kitchen piping.

2.2 SANITARY SEWER PIPING, ABOVE GRADE, DRAIN AND VENT

- A. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: ASTM C564, neoprene gasket system.
- B. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Neoprene gaskets and stainless-steel clamp-and-shield assemblies.
- C. PVC Pipe: ASTM D2665 (If approved by local authority), schedule 40, solid wall.
 - 1. Fittings: PVC.
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
 - 3. Not allowed for installation in any ceiling plenum areas.
 - 4. Not allowed for kitchen piping.
 - 5. Not allowed in any rooms adjacent to the Auditorium.

2.3 WATER PIPING, BURIED

- 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 B828
 - 3. NSF 61
- B. Cast Iron Pipe: AWWA C151:
 - 1. Fittings: Ductile iron, standard thickness.
 - 2. Joints: AWWA C111, rubber gasket with 3/4" (19 mm) diameter rods.
 - 3. NSF 61

2.4 WATER PIPING, ABOVE GRADE

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

3. NSF 61-G
4. ProPress Bronze, or copper pipe fittings are permitted for all sizes. ProPress Fittings: Bronze or copper shall conform to the material requirements of ASME B16.18 or ASME B16.22, and the performance requirements of IAMPO PS117, and ICC LC1002. ProPress fittings 1/2" thru 4" for use with ASTM B88 copper tube Type K, L, or M and 1/2" up to include 1-1/4" annealed copper tube. ProPress fittings shall have a 420 stainless steel grip ring, PBT separator ring, EPDM sealing element, and Smart Connect (SC) feature. Sealing elements shall be verified for the intended use. Installation must be in accordance with manufacturer's instructions and specifications. ProPress fittings with EPDM sealing element shall conform to NSF 61 pw when installed in a potable water system. Bronze fittings must meet the no lead requirements of NSF 61-G with a lead content of <0.25%.

- B. Copper Tubing: ASTM B88, Type L, hard drawn:
 1. Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper and bronze.
 2. NSF 61-G

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: ASTM D3034, SDR35 (Exterior)
 1. Fittings: PVC.
 2. Joints: ASTM F477, elastomeric gaskets.
- C. PVC Pipe: ASTM D2729 (if approved by local authority, Schedule 40, solid wall).
 1. Fittings: PVC
 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

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 ~~NATURAL~~ **PROPANE** GAS PIPING & ~~NATURAL~~ **PROPANE** GAS REGULATOR VENT PIPING, ABOVE GRADE (**Addendum 5**)

- 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. MegaPressG Fittings are suitable for installation of schedule 5 to Schedule 40 ASTM A53, A106, A135 and A795 Steel pipes.
- C. The only sealing element permissible on ~~natural~~ **propane** gas fuel lines is HNBR (Hydrogenated Nitrile Butadiene Rubber) and is yellow in color. The fitting shall be marked with a yellow dot indicating HNBR sealing element and a yellow rectangle indicating the fitting is suitable for gas.
- D. MegaPressG piping shall be bonded in accordance with section 310 of the international Fuel Gas Code.
- E. MegaPressG System ½" – 4" can be joined with off the shelf threaded fittings, provided the threaded connection be made first and the pressed connection made second.
- F. MegaPressG Fittings are approved for installation on fuel lines up to 5 psig delivery pressure.
- G. Fitting must be listed in accordance with ANSI LC-2/ CSA

2.8 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. PE Fittings: ASTM D 3261, butt fusion type with dimensions matching PE pipe.
 - 2. PE Transition Fittings: Factory fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 3. PE Piping Heat Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 4. Install underground, PE, natural gas piping according to ASTM D 2774.
 - 5. A yellow insulated copper tracer wire or other approved conductor, shall be installed adjacent to polyethylene piping. Access shall be provided to the tracer wire or the tracer wire shall terminate above ground at each end of the non-metallic piping. The tracer wire shall not be less than 18 AWG and shall be suitable for direct burial.~~
- 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.

2.9 CONDENSATE PIPING

- A. Copper Tube: ASTM B88, Type L hard drawn.
 - 1. Fittings: ASME B16.23, cast bronze or ASME B16.29, wrought copper.
 - 2. Joints: ASTM B32, solder, Grade 95TA.

- B. PVC Pipe: ASTM D2665 (concealed and roof areas only) (PVC piping is not permitted in any type of plenum space)
 - 1. Fittings: PVC
 - 2. Joints: ASTM D2855, solvent weld.

2.10 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

2.11 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, stainless steel ball, Teflon seats and stuffing box ring, lever handle with balancing stops, full port, solder, or threaded ends.
- C. Comply with NSF 61, Section 9.

2.12 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

2.13 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.

2.14 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.

2.15 FLOOR DRAIN (FD-2)

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

2.16 BACKFLOW PREVENTER

- A. Furnish and install a Watts Regulator Series LF909 with strainer. The Backflow Preventer shall be designed to provide cross connection control protection of the potable water supply in accordance with the 2018 Pennsylvania Plumbing Code and shall meet the requirements of the following standards ASSE 1013, CSA B64.5, NSF 61 and UL Classified File No EX3185. Listed by IAPMO (UPC).

2.17 WASHING MACHINE CONNECTION UNIT (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.

2.18 WALL HYDRANT (WH-1)

- A. Wall hydrant shall be Zurn #Z1320 encased, non-freeze, anti-siphon, automatic draining for flush installation type with 3/4" solder inlet, bronze casing, nickel-bronze face, brass operating parts, renewable nylon seat, vacuum breaker, and operating key

lock. Comply with NSF 61, Section 9. Wall hydrant shall have 1/2 turn ceramic disc cartridge and stainless-steel box and hinged cover. Install wall hydrant at 18" above finished grade.

2.19 WALL HYDRANT (WH-2)

- A. Furnish and install Vari-Temp combination hot and cold water, non-freeze, encased wall hydrant for flush installation, Zurn Model Z1325. Complete with bronze casing, all bronze interior parts, non-turning operating rods with free-floating compression closure valves, replaceable bronze seat and seat washer, and combination 3/4" female or 1" male straight IP inlet. Nickel bronze box and hinged cover with operating key lock and "WATER" cast on cover.

2.20 ROOF HYDRANT (RH-1)

- A. Furnish and install exposed, lead-free, non-freeze roof hydrant, Zurn Model Z1388XL. Hydrant shall have a cast iron head and lift handle with lock option, galvanized steel casing, bronze and stainless-steel interior components, 3/4" inlet connection with 1/8" tapped drain port on housing, and 3/4" male hose connection. Complete with cast iron roof support sleeve with wide anchoring flange and clamp collar.

2.21 HOSE BIBB (HB-1)

- A. Hose Bibb shall be Zurn-Z1350 encased moderate climate wall hydrant for narrow wall installation. Complete with bronze body, all bronze interior parts replaceable seat washer, screwdriver operated stop valve in supply, key operated control valve, and 3/4" solder inlet and 3/4" male hose connection standard. Stainless steel box and hinged cover with operating key lock and "WATER" stamped on cover.

2.22 ICE MAKER CONNECTION BOX (IMB-1)

- A. Furnish and install Guy Gray Metal Ice Maker Box Model M2B Series with quarter turn valve, outlet, box, faceplate, and white powder coat finish.

2.23 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.

2.24 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

2.25 LINE PRESSURE REGULATORS

- A. Comply with ANSI Z21.80.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Actaris.
 - 2. American Meter Company.
 - 3. Fisher
 - 4. Invensys
 - 5. Maxitrol Company.
- C. Body and Diaphragm Case: Cast iron or die-cast aluminum.
- D. Springs: Zinc-plated steel; interchangeable.
- E. Diaphragm Plate: Zinc-plated steel.
- F. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
- G. Orifice: Aluminum; interchangeable.
- H. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
- I. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
- J. Pressure regulator shall be lock-up style and shall maintain discharge pressure setting downstream, and not exceed 125% of design discharge pressure at shutoff.
- K. Overpressure Protection Device: Factory mounted on pressure regulator.
- L. Atmospheric Vent: Pipe to exterior, size per manufacturer's installation instructions
- M. Maximum Inlet Pressure: 5 psig
- N. Inlet Pressure: As noted on drawings .
- O. Outlet Pressure: As noted on drawings.

2.26 DEEP SINK FLOOR DRAIN (FS-1)

- A. Deep Sink Type Floor Drain shall be Zurn #Z-566 12" square open top drain. Acid-Resisting Epoxy-Coated Finish, cast iron body with bottom outlet, less seepage pan with loose set cast iron secondary strainer. Furnish with medium duty type grate (12" square). Contractor shall install with deep seal trap. Provide ProSet Trap Seal.

2.27 ~~TRIPLEX~~, **DUPLEX**, VARIABLE-SPEED BOOSTER PUMPS (DWBP-1)

- A. Manufacturers: Subject to compliance with requirements, the pumping system shall be **SyncroFlo** MODEL ~~PRO-22TH10XXX-6H-XX-SWF55-1~~ **PR1-22DH07XXX-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 ~~triplex~~ **duplex** variable speed water pressure booster system model ~~PRO-22TH10XXX-6H-XX-SWF55-1~~ **PR1-22DH07XXX-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 ~~200~~ **125** GPM when suction pressure is ~~30~~ **29** psig minimum using ~~460-208~~ volt, 3 phase, 60 hertz power.
- D. Pumps:
1. Pump shall be NSF certified close coupled end suction design with BULGED FORMED PROCESS 304 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. **Dual 7-1/2HP Motors** shall meet or exceed NEMA MG-1 Table 12-12 for epact motor efficiencies. Motors 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.

2.28 ROOF DRAIN (RD-1)

- A. *Furnish and install roof drain Model ZA-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.*

2.29 OVERFLOW STORM SPOUTS (OSS-1)

- A. *Overflow storm spout shall be Zurn Z199 nickel bronze body storm spout. Finish type shall be selected by Architect.*

2.30 OVERFLOW ROOF DRAIN (ORD-1)

- A. *Furnish and install where noted on drawings an overflow roof drain. Drain shall be Model ZA100ERC-W4 as manufactured by Zurn. Drain shall have dura-coated cast iron body with extension, roof sump receiver, 4" internal water dam and under deck clamp. Unit shall have combination membrane flashing clamp/gravel guard and low silhouette aluminum dome.*

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.

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. Balancing valves shall be similar to Bell & Gossett circuit setter type.
- 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, 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 a minimum of 1/4" per ft.
- W. All underground sanitary piping shall be minimum 2" size.
- X. Water hammer arrestors shall conform to ASSE 1010.
- Y. All changes of directions 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.

3.5 TEST OF WATER SUPPLYING SYSTEM

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

3.6 TESTS OF PLUMBING AND DRAINAGE SYSTEMS

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

END OF SECTION 220410

SECTION 220440 - PLUMBING FIXTURES & EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Water Closets
- ~~B. Urinals~~
- C. Lavatories
- D. Sinks
- E. Mop Basins
- F. Electric Water Coolers
- G. Showers
- H. Carriers
- I. Water Heaters
- J. Domestic Hot Water Circulating Pumps
- K. Expansion Tanks
- L. Thermostatic Mixing Valves

1.2 REFERENCES

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

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

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

- A. Furnish and install **wall-mounted** American Standard Aftwall Water Saver Toilet Model #2257.101. Unit shall be vitreous china with siphon jet action, elongated bowl, 1-1/2" top spud, and bolt caps. Unit shall be supplied with Church #5321.112 open front seat and Sloan Royal #111 ~~with sensor~~ flushometer Model EBV500A, exposed, chrome plated, diaphragm type, escutcheon, integral stop, and vacuum breaker (1.6 gpf) flushometer and carrier. Mount at height as shown on the Architectural Drawings. Water closet (WC-1) shall be ADA compliant.

~~2.2 URINAL (UR-1, UR-2)~~

- ~~A. Furnish and install wall mounted urinal. Unit shall be American Standard Washbrook FlowWise 0.5-gpf Ultra High Efficiency Urinal Model #6590.501, Sloan Royal #186-0.5 with sensor flushometer Model EBV500A, metal cover flush valve and wall hanger. Mount at height as shown on the Architectural Drawings.~~
- ~~B. Mount UR-1 at handicapped height.~~

2.3 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 on 4" centers suitable for concealed arms. Faucet shall be Sloan Optima Model ETF-600, sensor operated electronic faucet, plug-in transformer , ADA, below deck mixing valve, centerset faucet for 4" centers. Faucet shall be equipped with a flow restrictor and aerator 0.5 gpm, ADA approved. Unit shall be supplied with drain, McGuire #8872 adjustable P-trap, #169 flexible supply pipes and installed with carrier for concealed arms. Mount at height as shown on Architectural Drawings.
- B. Contractor shall provide insulation on all exposed pipes under lavatory to comply with ADA and Labor & Industry requirements. Insulation shall be by Truebro or equal.
- C. Provide lavatory mixing valve, Powers Hydro Guard Series LM495 thermostatic mixing valve (or equal).

2.4 SINK (SK-1)

- A. Furnish and install Elkay stainless steel double compartment Lustertone Sink Model #LRAD-331955 with 3 holes on 4" centers, 5-1/2" deep ADA bowl with off center drain. Faucets shall be Delta Commercial Model 27C2933 dual lever handle faucet with 8" centers, 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.
- B. Provide lavatory mixing valve, Powers Hydro Guard Series LM495 thermostatic mixing valve (or equal).

2.5 SINK (SK-2)

- A. Furnish and install Elkay stainless steel single compartment Lustertone Sink Model #LRAD-2219 with 3 holes on 4" centers, with off center drain. 5-1/2" deep ADA bowl, Faucet shall be Delta Commercial Model 100LF-HDF single lever handle faucet with 8" centers, standard 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.
- B. Provide Sink mixing valve, Powers Hydro Guard Series LM495 thermostatic mixing valve (or equal).

2.6 WATER COOLER (EWC-1)

- A. Furnish and install wall hung bi-level Halsey Taylor Barrier-Free Water Cooler(s) Model HTHBHVR8BL with capacity to cool at least 8 gph of water entering at 80°F and leaving at 50°F with room temperature of 90°F. Unit shall have built-in pressure regulator and solenoid valve controlled by a front push-button. Cooling tank shall be storage type with capacity of at least 2 pints and be vented, red brass with copper refrigerant coil bonded to exterior and hot-tin dipped after assembly. The refrigerant flow shall be controlled by a capillary tube. The temperature shall be controlled by an adjustable thermostat. Unit shall be furnished and installed with bottle filling station mounted integral to water cooler.
- B. The entire cooler shall be warranted for 5 years. Furnish in stainless steel finish. Entire unit shall be "lead-free". Unit shall meet ADA requirements. Mount at height per Architectural drawings.
- C. Water coolers shall be piped with inline water filter sized for unit. Install filter in accessible location.
- D. Furnish and install with Model #98324C Cane Apron in locations without a wing wall.
- E. Water cooler EWC-1 shall have the low side ADA height on left side with bubbler. Water cooler EWC-2 shall have the low side ADA height on right side with bubbler. Refer to elevations on architectural drawings for additional information.

2.7 MOP BASIN (MB-1)

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

2.8 DOMESTIC HOT WATER CIRCULATING PUMP (CP-1)

- A. Furnish and install domestic water circulating pumps. The pump shall be all bronze construction for domestic hot water service. The pump shall be of the horizontal, oil-lubricated type, specifically designed and guaranteed for quiet operation. Suitable for 125# working pressure.
- B. The pumps shall have a ground and polished steel shaft with integral thrust collar. The shaft shall be supported by two horizontal sleeve bearings designed to circulate oil. The pumps are to be equipped with a water-tight seal to prevent leakage. Mechanical seal faces to be carbon on ceramic. The motor shall be non-overloading at any point on pump curve.
- C. The motor shall be of the open, drip-proof sleeve-bearing quiet operating, rubber-mounted construction. Motors shall have built-in thermal overload protectors.
- D. Circulator Pumps shall be Bell & Gossett Model PL Series or approved equal by TACO or Armstrong. Pump shall have a capacity of 25 GPM at 30' head and shall be 2/5 HP 120V/1Ø (CP-1), and 5 gpm at 15' head and shall be 1/6 HP (120 V/1Ø) (CP-2).
- E. The system shall be provided with a bronze balancing valve and bronze shutoff valves for flow adjustment and maintenance.

2.9 EXPANSION TANK (ET-1)

- A. furnish and install an Expansion Tank Model ST-42V-C by Therm-X-Trol. Tank(s) shall be diaphragm type specifically designed for potable water and shall be ASME stamped.

2.10 TRENCH DRAIN (TD-1)

- A. Furnish and install trench drain Model KERDI LINE as manufactured by Schuler or approved equal. Unit shall have a brushed stainless steel closed design grate. Unit shall be 36" long. Unit shall be suitable for wheelchair accessible showers.

2.11 ACCEPTABLE SUBSTITUTES:

- A. Water Closets, Urinals, Lavatories – American Standard, Kohler, Zurn
- B. Faucets – American Standard, Chicago Faucets, Speakman, Moen Commercial, Delta Commercial, T&S Brass
- C. Showers - Delta, Bradley
- D. Flush Valves - Sloan, Zurn, Moen Commercial
- E. Coolers - Elkay, Oasis, Halsey Taylor
- F. Seats - Beneke, Kohler, American Standard
- G. Sinks – Kohler, Just, Elkay

2.12 ELECTRIC HEAT TRACING

- A. The heat tracing shall be capable of maintaining a minimum water temperature of 40°F at an ambient air temperature of -10°F with pipe covered by 1" fiberglass insulation.
- B. The electric heat tracing shall be of a self-regulating XL-Trace heater manufactured by Raychem Corporation or equal by Thermon. The heater shall respond to varying localized temperature conditions along the pipe by self-regulating its heat output at each point along its length without reliance on thermostat controls.
- C. Operating energy shall be conserved by the self-regulating feature of the heater materials which automatically controls heat output in proportion to the heat requirement. Operating safety shall be increased by the absolute heater temperature limit built into the self-regulating heater material without a reliance on thermostats. A constant wattage heater shall not be acceptable.
- D. The electrical heat tracing shall consist of flat, flexible, low-heat density electric heat tracing strip of parallel circuit construction, consisting of 16 AWG bus bars and a continuous inner core of self-regulating conductive material, this core shall be insulated with a radiation cross-linked polyolefin jacket. The heat tracing strip shall be capable of being cut to the desired length in the field. Raychem>SK components shall be used for all power connection points, heat tracing tees and end seal terminations.
- E. The heater shall operate on 120 volts. Plumbing contractor shall provide connection point for Electrical Contractor to install local disconnect and power.
- F. The self-regulating heater, in combination with the interconnect components, shall have a UL System listing.
- G. Furnish and install 1 ambient sensing thermostat (Model AMC-1A) set at 40°F connected in series with a Model AMC-13 thermostat with a capillary tube attached to pipe and set at 40°F. Electric heat tracing shall be energized when contacts on both thermostats are closed. (i.e. – ambient temperature below 40°F and pipe wall temperature below 40°F). Each pipe run shall be furnished with a separate circuit and separate thermostat with capillary tube.
- H. All piping with heat trace shall be insulated with 1" thick insulation. Refer to Specification Section 22 0250.
- I. Plumbing contractor shall provide all heat tracing and thermostats required for a complete installation.

2.13 WATER HEATERS (DWH-1, *DWH-2, DWH-3*)

- A. The ~~Phoenix®~~ **NPE-2 Series** Gas-Fired Water Heater shall be manufactured by ~~HTP~~ **Navien** with an identification of model number ~~PH-199-119~~ **NPE-240-S2 tankless, instantaneous, condensing**, or approved equal and a modulation input range of ~~40,000—199,000~~ **13,300 – 199,900** Btu/Hr. The ~~Phoenix®~~ **NPE-240-S2** Gas-Fired Water Heater shall operate on ~~natural~~ **propane** gas.
- B. The heater ~~tank~~ shall ~~be constructed of 316L~~ **have dual primary and secondary** stainless steel **heat exchangers**. The primary condensing heat exchanger shall be constructed of ~~90/10~~

~~cupronickel~~ **stainless steel**. The secondary heat exchanger shall be constructed of ~~800H~~ stainless steel. ~~and 90/10 cupronickel.~~

- ~~C. Tank insulation shall be 2" thick water blown foam. Insulation shall be enclosed in a plastic jacket. All components shall be located on the front of the heater for easy service access. All related hardware shall be constructed of stainless steel studs with brass nuts. All water connection nipples shall be constructed of stainless steel and attached to the side of the tank. Multi Fit models shall have additional top mounted piping connections to increase installation flexibility. The top and bottom of the tank shall be smooth.~~
- D. The water heaters shall be ~~ETL~~ **CSA group** listed and certified to ANSI Z21.10.3-CSA 4.3 standard governing ~~storage tank~~ water heaters with input ratings above 75,000 BTU/Hr. Water heaters shall exceed the minimum thermal efficiency and standby loss requirements of the United States Department of Energy and current edition of ASHRAE/IESNA 90.1. All heaters will be supplied with a factory installed ASME rated temperature and pressure relief valve, a low water cutoff, a high temperature switch, an upper hot water sensor, a lower cold water sensor, and a condensate trap assembly ready for easy connection to a field supplied condensate drain.
- E. The heater shall have an integrated digital controller device with integral diagnostics, LED fault and temperature settings for establishing set point and temperature differential. Ignition shall be direct spark and take place at a speed pre-set for the burner blower. The control shall utilize an algorithm to fully adjust the burner modulating firing rate while maintaining the desired temperature. The pre-mix stainless steel burner uses a 120-volt motor with ~~pulse wave modulation~~ control to change the fan speed, thus the combustion air volume of fuel and air through the burner to establish a continuous BTU input range equal to the water heating set point requirement. The digital LED control display shall provide means, ~~via push buttons~~, for adjustments of operating temperatures, differential adjustment, ECO reset, service mode, and real time status mode. The control shall have low voltage inputs to accept a 0-10 volt from a building management system or outdoor sensor to alter the set point of the water heater. The unit will also have line voltage outputs for connection to a condensate pump and alarm output that will alert user of fault in the water heater for service. In addition, there shall be provided a computer connection for history, including all fault codes and hours of operation above 50% input, below 50% input, as well as real-time status reporting of all operations. ~~The burner assembly shall be mounted so as to be easily removed as an integral unit for ease of service.~~ **Provide Wi-Fi connected controls, (Navlink) for Wi-Fi control of unit.**
- F. The heater combustion system shall be two pipe (intake and exhaust) closed combustion. ~~Schedule 80 PVC~~ **Schedule 40/80 heavy wall PVC, CPVC, Polypropylene** or stainless steel piping materials are approved for venting applications (see installation manual for further venting details). The vent connections (intake and exhaust) shall be located on the ~~bottom~~ **top** of the heater.
- ~~G. Appliance venting shall be installed using vertical venting done as a balanced system.~~
- H. The total combined length of exhaust and intake vents cannot exceed ~~85~~ **75** combined feet for 2" venting or ~~200~~ **150** combined feet for 3" venting. Adequate combustion air must be supplied when drawing air from the mechanical room. Avoid the room contaminates listed in the installation

manual. (Refer to appliance installation manual venting section for additional venting requirements.)

- I. The heater shall be in compliance with the NOx emissions limit set forth in SCAQMD Rule 1146.2. The heater shall be factory assembled, test-fired for correct BTU input, and adjusted for proper combustion parameters. Complete operating and installation instructions shall be furnished with every heater as packaged by the manufacturer for shipping.
- J. The surfaces of these products contacted by consumable water contain less than 0.25% lead by weight, as required by the Safe Drinking Water Act, Section 1417.

2.14 SINK (S-3)

- A. **Furnish and install wall mounted Zurn-Elkay Stainless Steel single compartment utility sink with gooseneck faucet on 8" centers. Shall be Zurn-Elkay CHS1716C, 16-3/4" x 15-1/2", wall-mounted hand sink constructed of 20-gauge type 304 stainless steel with buffed satin finish. Shall be rust and corrosion resistant. Shall have 6" deep bowl with backsplash. Provide 4" gooseneck faucet, cast iron 'P' trap, lever handles, and wall hanger.**
- B. **Provide sink mixing valve, powers hydro guard, series LM495 thermostatic mixing valve.**

2.15 WATER CLOSET (WC-3, WC-4)

- A. ***Furnish and install American Standard Madera Water Save Floor-Mounted Toilet Model #3043.001.020-B. Unit shall be vitreous China with siphon jet action, elongated bowl, 1-1/2" top spud, and bolt caps. Unit shall be supplied with American Standard open front seat and American Standard sensor flushometer Model 3043.001-B, exposed, chrome plated, diaphragm type, escutcheon, integral stop, and vacuum breaker (1.6 gpf) flushometer and carrier. Water closet (WC-3) shall be ADA compliant.***
- B. ***Water closet (WC-4) shall be non-ADA height, non-ADA compliant toilet with same trim, flushometer valve, seat, etc. as WC-3. Floor-mounted, "right-height" elongated toilet, American Standard Model No. 3043.528.020, Madera, 1.28 gallons per flush, flushometer with open front seat.***

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. Demolition
 - 2. VAV Boxes
 - 3. Packaged Rooftop Air Handling Units
 - 4. Fan Coil Units
 - 5. Exhaust Fans
 - 6. Make-Up Air Unit
 - 7. Mini-Split System Units
 - 8. Vertical Split System Air Handlers (Alt Bid)
 - 9. Hot Water Cabinet Heaters, Unit Heaters and Baseboard Heaters
 - 10. Ductwork Systems
 - 11. Diffusers, Registers & Grilles
 - 12. Roof Ventilators
 - 13. Hot Water Heating System Including Pumps, Piping, Etc.
 - 14. Hot Water System Piping Insulation
 - 15. ATC Control System
 - 16. Testing, Adjusting and Balancing
 - 17. Commissioning

1.3 DEFINITION OF WORK RESPONSIBILITY

- A. All electrical control components including starters required for operation of mechanical 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 mechanical equipment. Refer to Specification Section 260180 for Matrix of Responsibility.

- 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 mechanical equipment or components shall be supplied by the mechanical contractor.
- 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.

1.4 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.

1.5 DEFINITIONS

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

1.6 DRAWINGS

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

1.7 SUBMITTAL OF SHOP DRAWINGS FOR REVIEW

- A. 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.

1.8 SUBSTITUTIONS

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

1.9 SUBMITTALS FOR CLOSEOUT

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

1.10 WARRANTY

A. The Contractor shall submit the following guarantee:

1. Written **one (1)** year full warranty guarantees shall be submitted for the entire mechanical installation installed under this project. The warranty shall begin at substantial completion of the project. If the manufacturer's warranty begins when the

equipment ships or is ordered, then the Contractor shall extend the warranty to cover the construction period plus the warranty specified under substantial completion. If the manufacturer's standard guarantee provides for a longer period, the longer period shall apply.

2. Where defects in the material, equipment and/or workmanship become evident within this guarantee period, the Contractor shall be responsible for providing new manufacturer approved material and equipment, and/or correcting the defective workmanship without any costs to the Owner.

- B. During such a period, and before the expiration of each such guarantee, contractor shall agree to make any and all repairs, adjustments, or replacements which may become necessary, owing to initial settlement or shrinkage, defective material, workmanship, or installation.
- C. He shall further agree to provide all labor and material which may be required and to restore to its original condition any adjacent work that he may disturb in making the necessary repairs, adjustments, or replacements in order to fulfill this guarantee.

1.11 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.

1.12 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.

1.13 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.

1.14 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.

1.15 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.

1.16 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.

1.17 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.

1.18 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.

1.19 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.

1.20 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.

1.21 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.

1.22 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.

1.23 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.
- 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.

1.24 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.

1.25 ACCESS

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

1.26 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.

1.27 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.

1.28 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.

1.29 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. (See attached). Functional testing shall be completed by the HVAC Contractor together with his ATC Sub-Contractor in the presence of the Owner and Engineer.

- 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.

1.30 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. Additionally, furnish one set of filters. 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. Equipment that is to be installed exposed in a space shall be installed in a manner that minimizes any gaps around the equipment while still allowing service access. Filler panels matching equipment dimensions shall be used to close off any gaps and shall be in the same color as the equipment.
- C. Provide access panels in equipment, ducts, etc. as required for inspection and maintenance.
- D. All equipment on roof shall be secured to roof supports. Unfastened equipment is not acceptable. All equipment shall be located at least 10’-0” from any roof edge more than 30” above adjacent roof or grade or provide fall protection if conditions do not allow equipment to be 10’-0” from edge.

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: _____

RTU ☐ AH ☐ 100% MAU ☐ HRU ☐ VAV ☐ EF ☐

SPACE TEMP	FAN STARTS	YES ☐	NO ☐
	O.A. DAMPER CLOSED	YES ☐	NO ☐
	FAN STARTS	YES ☐	NO ☐

WARMUP	R.A. DAMPER OPEN	YES ☐	NO ☐
	RELIEF DAMPER CLOSED	YES ☐	NO ☐
	HEAT VALVE MODULATES OPEN	YES ☐	NO ☐

OCCUPIED HEAT	O.A. DAMPER TO MIN. POSITION	YES ☐	NO ☐
	R.A. AND RELIEF MOD. PROPORTIONAL TO O.A. DAMPER	YES ☐	NO ☐

OCCUPIED COOL H/W VALVE	MOD. CLOSED	YES ☐	NO ☐
	O.A. DAMPER MOD. OPEN	YES ☐	NO ☐
	R.A. & RLF MOD. PROP. TO O.A.	YES ☐	NO ☐

UNOCCUPIED	FAN STOPS	YES ☐	NO ☐
	O.A. DAMPER CLOSED	YES ☐	NO ☐
	R.A. DAMPER OPEN	YES ☐	NO ☐

FAN CYCLE & H/W VALVE	MOD OPEN TO MAINTAIN	YES ☐	NO ☐
	SETBACK TEMP	YES ☐	NO ☐

FREEZE CONTROL	FAN STOPS	YES ☐	NO ☐
	O.A. DAMPER CLOSES	YES ☐	NO ☐
	HEAT VALVE OPEN	YES ☐	NO ☐

FIRE/SMOKE CONTROL	FAN STOPS	YES ☐	NO ☐
	O.A. DAMPER CLOSES	YES ☐	NO ☐

DISCHARGE AIR TEMP HEATING _____ COOLING _____

RETURN AIR TEMP HEATING _____ COOLING _____

NOTES:

TECHNICIAN _____ OWNER REP. _____
DATE _____

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

SECTION 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

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

2.5 DIAL THERMOMETERS

- 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. Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 - 1. Size: 3-1/2" diameter dial
 - 2. Lens: Clear glass
 - 3. Accuracy: 1%
 - 4. Calibration: Both °F and °C

2.6 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. 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.

2.9 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 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.

2.13 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).

2.14 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.

2.15 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.

2.16 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.

2.17 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.

2.18 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.

2.19 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.

2.20 ROOF EQUIPMENT SUPPORTS

- A. Provide roof equipment support as manufactured by Pate Co. Style ES or approved 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.

2.21 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.

2.22 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 (RTU's, EF's, etc.) shall be mounted at the unit on the roof and shall be NEMA rated, weatherproof for exterior installation.

2.24 VIBRATION ISOLATION ROOF CURB

- A. Rooftop HVAC units shall be supported by vibration isolation curbs Model ESR as manufactured by Kinetics Noise Control or equal by Mason. The vibration isolation curbs shall be complete assemblies designed to re-silently support the equipment at the specified elevation and shall constitute a fully enclosed air and weather-tight system.
- B. The isolation curb shall consist of an upper support rail with supply and return duct supports on which the equipment and duct openings rest and a lower support curb which is attached to the roof structure, separated by free-standing, unhoused, laterally stable steel springs.

- C. The upper support rail shall provide continuous structural support for the rooftop equipment and shall be designed to provide isolation against casing-radiated vibration in the rooftop equipment housing and structure borne vibration from rotating and mechanical equipment in the rooftop package.
- D. The upper support rail shall consist of a structural channel shape with a sufficient elevation above the spring to preclude interference with the rooftop equipment and permit access to inspect the isolation system after placement of the rooftop equipment.
- E. The lower support curb shall be a formed channel fabricated of heavy gauge galvanized steel with a continuous 1-1/2" x 1-1/2" nominal wood nailer attached to the isolation support pedestals. The isolation support pedestal, which includes the seismic and wind load restraints, shall be bolted or welded to the building support steel to suitable transfer seismic and wind load forces to the building structure. The lower support curb shall have a minimum elevation of 14" from the top of the wood nailer to the base of the curb.
- F. Spring components shall be 2" deflection, free-standing, unhoused, laterally stable steel springs. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed for a typical 50% overload to solid. All springs shall have an epoxy-based, powder-coated finish and be color coded to indicate load capacity. Spring coils shall rest on minimum 0.25" neoprene noise pads.
- G. Seismic and wind load restraints shall be designed to limit movement in all directions. Restraint components shall include neoprene snubbers at all contact points for energy absorption. There shall be no metal-to-metal contact.
- H. The vibration isolation curb shall be air and weather tight using an elastomeric seal, which is attached to the upper support frame with a galvanized steel clip. The seal shall extend down past the wood nailer of the lower support assembly and flash over the roof material at the wood nailer on the lower support curb. The seal shall be Class A, as tested in accordance with approved UL, Inc. provisions. Metal or combination metal and elastomer seals are not permitted.
- I. The isolation curb system shall be complete with cross-bracing as required as a part of the upper and lower assemblies.
- J. Supply and return duct support hardware shall be supplied for installation by the contractor in the field. The duct supports will be clearly marked and dimensioned on the submittal and installation drawings. The duct support hardware shall be cut-to-length, galvanized steel channels supported and connected with stamped and punched galvanized steel duct support hangers. The duct support hangers shall allow the duct support elevation to be equal to or lower than the equipment rail elevation. Supply air and return duct shall be flexibly attached by the contractor to prevent transmission of vibration to the building structure.
- K. Airborne noise control packages, if required, shall be supported by the roof structure within the curb and shall have no rigid contact with the isolation curb.
- L. The isolation curb assemblies shall be shipped to the job site with the upper support rail, lower support curb, springs and restraints completely assembled. The contractor shall be required to

assemble the four corners, attach the curb to the roof structure, install cross-bracing and duct supports as necessary, and install and attach rooftop equipment.

- M. Vibration isolators shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.
- N. Provide high-mass composite floating floor in bottom of curb (Acoustical Treatment Package RT-4S4)/
- O. Infill Metal Panels: Provide laminated infill panels where indicated on the Drawings and constructed as follows:
 - 1. Thickness: 2" nominal
 - 2. Inside and Outside Panel Faces: .024" smooth aluminum
 - 3. Stabilizers: High density polyethylene
 - 4. Insulation: Isocyanurate
 - 5. Finish: Both sides of the panels shall be painted color selected by the Architect.
 - 6. Manufacturers: Panels shall be equal to GlazeGuard WR as manufactured by Citadel.
 - a. Citadel Architectural Products
 - b. Laminators, Inc.
 - c. Mapes

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. Guages 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 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 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-ga 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

B. Stem Type Thermometer Schedule:

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

C. Supports and Hangers:

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

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping Insulation
- B. Jackets and Accessories
- C. Equipment Insulation
- D. Covering
- E. Ductwork Insulation
- F. Duct Liner
- G. 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
- F. International Energy Conservation Code - 2015

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. Armstrong
 - 4. PPG

2.2 DUCT INSULATION

- A. Provide and install acoustic and thermal lining in all supply air, fresh air, transfer air, return air, and energy recovery exhaust air ductwork as specified. Exhaust only ductwork not connected to an energy recovery unit does not need insulated unless specifically noted. All round ductwork exposed in an occupiable space shall be double-wall spiral insulated duct. Insulation shall be in compliance with the International Energy Conservation Code.
- B. Lining shall be 1.5" thick fiberglass semi-rigid board type, or duct liner, 2.0 PCF density, with a thermal conductivity of approximately 0.16 k Btu • in/hr • ft² • °F in thickness required to achieve an R-value of 6.0 or greater.
- C. For ductwork identified on the contract drawings as not lined, as specified above, the ductwork shall be wrapped with Fiberglass All Service Duct Wrap similar to Owens Corning Type 150, 1.50 lbs. per cubic foot density with a thermal conductivity of approximately 0.25 k Btu • in/hr • ft² • °F in thickness required to achieve an 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 or building exterior) 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. Ductwork installed on the building exterior shall be covered with Aluma Guard 60 (White) membrane or equal.
- F. Spiral ductwork upstream of VAV boxes shall be wrapped with 1.5" fiberglass duct wrap, not lined, with a thermal conductivity of approximately 0.16 k Btu • in/hr • ft² • °F and an R-value of 6.0 or greater.
- G. 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 AND EQUIPMENT INSULATION

- A. All HVAC supply and return water pipes, fittings, suction diffusers, pumps, water tanks, hot surfaces, flanges, and valves shall be insulated with heavy density fiberglass insulation, similar to

Owens/Corning Fiberglass 25ASJ/SSL pipe insulation or accepted substitute, with all service jacket, self-sealing lap and U.L. listed.

- B. Pipe and equipment insulation shall meet or exceed the IECC conductivity and thickness requirements. Piping and equipment insulation thickness shall be as listed in section 3.2.M of this specification.

2.4 REFRIGERANT PIPING

- A. All refrigeration lines shall be insulated in accordance with IECC Table C403.2.10 above with flexible elastomeric closed cell pipe insulation, Armaflex FR/Armaflex or approved equal having flame spread rating of 25 or less when tested by ASTM-84 method.
- B. All exposed FR/Armaflex insulation shall be finished with two coats of Armstrong Armaflex Finish or accepted substitute. Color to be selected by Architect.
- C. All exterior refrigeration piping shall be insulated with 1" FoamGlass Insulation by Pittsburg-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 also 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: (In accordance with ASHRAE 90A-1980)
1. Hot Water Supply, Return:

<u>Pipe Size</u>	<u>Thickness</u>
Up to 1-1/2"	2"
2" to 12"	2"

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. All exposed ductwork shall be lined. Duct wrap 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
- B. Valves:
 - 1. Gate Valves
 - 2. Ball Valves
 - 3. Check Valves
 - 4. Butterfly Valves
- C. Air Vents, Air Separators
- D. Expansion Tanks
- E. Pump Specialties

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 HEATING WATER, PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53, Schedule 40, black.
 - 1. Fittings: ASTM B16.3, malleable iron, or ASTM A234, forged steel welding type fittings.
 - 2. Joints: Threaded, (up to 2") or AWS D1.1, welded (over 2" size).
 - 3. For piping 2-1/2" and larger, a coupling system will be acceptable for couplings, tees, reducers, elbows, valves, and strainers as specified herein. Provide proper gaskets for reducers, elbows, valves, and strainers as specified herein. Provide proper gaskets for system working temperature and pressure. Acceptable manufacturers shall be Victaulic (Basis of Design) or Gruvlok.
 - a. Victaulic standard fittings will be ASTM A536 ductile iron, ASME A234 forged steel, or ASTM A53 fabricated steel, with factory grooved ends designed to accept Victaulic standard couplings.
 - b. Victaulic standard couplings consist of two ASTM A536 ductile iron housing segments, a pressure-responsive synthetic rubber gasket, grade "E" EPDM for water services to 230°F, secured together with plated steel bolts and nuts.
 - 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.
- C. Press-Fit Piping
 - 1. Tubing standard: copper tubing shall conform to ASTM B75 within Viega specifications or ASTM B88.
 - 2. Fitting standard: copper fittings shall conform to ASME B16.18, ASME B16.22, or ASME B16.26. Engineering Specifications SM-PP 1120 ProPress Systems 8 of 31
 - 3. Press fitting: copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of ASME B16.51 and IAPMO PS 117 (IAPMO PS 117 is not for B75). Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have Smart Connect® technology. In ProPress 1/2" to 4" dimensions, Viega's unique Smart Connect technology allows identification of an unpressed fitting during pressure testing. The function of this feature is to provide the installer quick

and easy identification of connections which have not been pressed prior to putting the system into operation.

4. Threaded fittings: pipe threads shall conform to ASME B1.20.1.
5. Hanger standard: hangers and supports shall conform to MSS-SP-58.

2.2 BACKFLOW PREVENTER

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

2.3 REFRIGERANT PIPING

- A. Copper Tubing: ASTM B280, Type ACT 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 services.

2.4 DIAPHRAGM-TYPE EXPANSION TANKS

- A. Manufacturers
 1. Basis of Design: Amtrol
 2. Taco
 3. John Wood
- B. Construction: Welded steel, tested and stamped in accordance with ASME SEC 8-D; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible butyl diaphragm sealed into tank, and steel support stand for vertical tanks.
- C. Accessories: Pressure gauge and air-charging fitting, tank drain, pre-charge to 12 psig.

2.5 AIR SEPARATORS

- A. In-Line Air Separators:
 1. Manufacturers:
 - a. Basis of Design: Bell & Gossett
 - b. Taco
 - c. Armstrong
 - d. Amtrol
 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.

2.6 PUMP SUCTION DIFFUSERS

- A. Manufacturers:
 1. Basis of Design: 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.

2.7 TRIPLE DUTY VALVES

- A. Manufacturers:
 1. Basis of Design: 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.

2.8 PIPE HANGERS AND SUPPORTS

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

2.9 GATE VALVES

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

2.10 HVAC BALL VALVES

- A. Up to and Including 3 Inches:
- B. Manufacturers:
 - 1. Nibco
 - 2. Crane
 - 3. Stockham
- C. Bronze two-piece body, stainless steel ball, Teflon seats and stuffing box ring, lever handle with balancing stops, solder, or threaded ends.

2.11 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Nibco
 - 2. Crane
 - 3. Jamesbury
 - 4. Victaulic
 - 5. Gruvlok
- 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. 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.
- F. 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.

2.12 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Nibco
 - 2. Crane
 - 3. Stockham
 - 4. Victaulic

5. Gruvlok

- 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.

2.13 AIR VENTS

- A. Manufacturers:
 - 1. Bell & Gossett
 - 2. Taco
 - 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.

2.14 STRAINERS

- A. Manufacturers:
 - 1. Sarco
 - 2. ITT Hoffman
 - 3. Bell & Gossett
- 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 hinge3d closure for strainer maintenance, AGS grooved ends, 300 psi per CWP. Victaulic Series W730.

2.15 FLOW CONTROLS

- A. Manufacturers:
 - 1. Bell & Gossett Circuit Setter Plus
 - 2. Taco
 - 3. Armstrong CBU

4. Tour and Anderson

- 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.
- C. Self-balancing valves are not permitted.

2.16 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.

2.17 ELECTRIC HEAT TRACING

- A. Electric heat tracing, for the purpose of freeze protection shall be installed on all piping installed above roof.
- B. The heat tracing shall be capable of maintaining a minimum water temperature of 40°F at an ambient air temperature of -10°F with pipe covered by 1" fiberglass insulation.
- C. The electric heat tracing shall be of a self-regulating XL-Trace heater manufactured by Raychem Corporation or equal by Thermon. The heater shall respond to varying localized temperature conditions along the pipe by self-regulating its heat output at each point along its length without reliance on thermostat controls.
- D. Operating energy shall be conserved by the self-regulating feature of the heater materials which automatically controls heat output in proportion to the heat requirement. Operating safety shall be increased by the absolute heater temperature limit built into the self-regulating heater material without a reliance on thermostats. A constant wattage heater shall not be acceptable.
- E. The electrical heat tracing shall consist of flat, flexible, low-heat density electric heat tracing strip of parallel circuit construction, consisting of 16 AWG bus bars and a continuous inner core of self-regulating conductive material, this core shall be insulated with a radiation cross-linked polyolefin jacket. The heat tracing strip shall be capable of being cut to the desired length in the field. Raychem>SK components shall be used for all power connection points, heat tracing tees and end seal terminations.
- F. The heater shall operate on 120 volts. Mechanical contractor shall provide connection point for Electrical Contractor to install local disconnect and power.
- G. The self-regulating heater, in combination with the interconnect components, shall have a UL System listing.

- H. Furnish and install 1 ambient sensing thermostat (Model AMC-1A) set at 40°F connected in series with a Model AMC-13 thermostat with a capillary tube attached to pipe and set at 40°F. Electric heat tracing shall be energized when contacts on both thermostats are closed. (i.e. – ambient temperature below 40°F and pipe wall temperature below 40°F). Each pipe run shall be furnished with separate circuit and separate thermostat with capillary tube.
- I. All piping with heat trace shall be insulated with insulation in thickness as listed in specification section 230250.
- J. Mechanical contractor shall provide all heat tracing and thermostats required for a complete installation.

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.
- V. Provide traps at condensate pipe connection to all units.
- W. 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. Inline Pumps
- C. 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 BASE MOUNTED PUMPS

- A. Manufacturers:
 - 1. Bell & Gossett Model e1510 (Basis of Design)
 - 2. Other acceptable manufacturers offering equivalent products:
 - a. Armstrong
 - b. Aurora
 - c. Penn Pump Co.
 - d. Taco
 - e. **Grundfos (Addendum 1)**
- B. The pump shall be single stage, vertical split case design, in cast iron and bronze fitted construction. The pump internals shall be capable of being serviced without disturbing piping connections or motor.
- C. The impeller shall be of the enclosed type, dynamically balanced and keyed to the shaft and secured with a suitable locknut.
- D. Pump shall be standard single mechanical seal with carbon seal ring and ceramic seat. Provide with wear ring.
- E. A replaceable shaft sleeve shall be furnished to cover the wetted area of the shaft under the seal or packing.
- F. The bearing frame assembly of the pump shall be fitted with re-greasable ball bearing equivalent to electric motor bearing standards for quiet operation.
- G. 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.
- H. 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.
- I. Pump motors shall be premium high efficiency.
- J. Pump shall be provided with motor starter disconnect for each pump.

2.2 INLINE CIRCULATOR PUMP

- A. Manufacturers:
 - 1. Bell & Gossett Model 60 or 80 (Basis of Design)
 - 2. Approved substitutes:
 - a. Aurora

- b. Armstrong
 - c. Penn Pump Co.
 - d. Taco
- B. The pumps shall be of a horizontal, permanently lubricated, specifically designed, and guaranteed for quiet operation. Suitable for 225°F operation at 175 psig working pressure. The pump shall be single stage, vertical split case design, in cast bronze fitted construction. The pump internals shall be capable of being serviced without disturbing piping connections.
- C. The pumps shall be composed of 3 separable components; a motor, bearing assembly, and pump end (wet end). The motor shaft shall be connected to the pump shaft via a replaceable flexible coupler.
- D. The pumps shall have a solid SAE 1144 steel shaft supported by 2 ball bearings. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.
- E. Pump shall be equipped with an internally flushed mechanical seal assembly. Seal assembly shall have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
- F. Bearing assembly shaft shall connect to either a cast bronze impeller. Impeller shall be both hydraulically and dynamically balanced, keyed to the shaft and secured by a locking cap screw or nut.
- G. A flexible type coupling to dampen starting torque and torsional vibration shall be employed between the pump and motor.
- H. Pump shall be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
- I. Pump volute shall be of cast iron design for heating systems. The connection style on cast iron and bronze pumps shall be flanged. Volute shall include gauge ports at nozzles and vent and drain ports.
- J. To ensure alignment the motor shall be mounted to the bearing assembly via a bolted motor bracket assembly, and a rubber mount will be used to assist in aligning the motor shaft with the pump shaft.
- K. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors through 1 HP shall be resilient mounted, motors over 1.5 HP shall be rigid mounted. Motors shall have permanently lubricated ball bearings and must be maintenance free. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
- L. Each pump shall be factory tested and name-plated before shipment.
- M. Pump shall be provided with motor starter/disconnect for 3-phase motors.

2.3 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 (Basis of Design) 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 feet of motor cable. **No Exceptions.** 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, **no exceptions.**
 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 IEEE519-1992.
 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.
- 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.
- E. 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 mADC and digital signals shall be dry for C contacts. Analog signals shall be able to be monitored from the building automation system.

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 Requiring 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. Provide quarterly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

PART 2 - PRODUCTS

2.1 MANUFACTURER/TREATMENT AGENCY

- A. ~~5.0 Rochester Midland Corporation—Contacts Greg Atland gatland@rochestermidland.com, (585) 336-2200 or Bill Elgin (717) 478-4222.~~ ***R.L. Clarke Enterprises Inc – Contact 717-371-2300, rlclarke@rlclarke.com***
1. ***Contractor shall contact RLC to coordinate “flush and fill” method for removing system cleaners completely from the closed loop systems.***
 2. ***No Substitutes (Addendum 1)***

2.2 BY-PASS (POT) FEEDER

- A. 5.0 gal with quick opening cap for working pressure of 175-psig.

2.3 CHEMICAL FEEDING AND CONTROL EQUIPMENT CLOSE CIRCUIT WATER FEED SYSTEM

- A. Contractor shall install the following apparatus (including all external piping and wiring).
- B. One (1) Aquatrac AEGIS or equal conductivity controller for automatic control of cooling system bleed-off. The conductivity controller shall be fully transistorized with plug-in printed circuit boards and housed in a durable flame retardant plastic enclosure which can be wall or flush-panel mounted. The controller shall provide linear, temperature compensated measurements directly in micromhos over full scale.
1. Conductivity measurement shall be displayed on a 2" digital display.
 2. Power switch, set point adjustment, test button, calibration screw, indicating lights and meter shall all be front panel mounted for easy access.
 3. Controller shall have dual biocide schedule built into the programming. Alternating biocide scheduling is necessary.
 4. LAN and Ethernet connectivity. Provide software to owner for direct connectivity.
 5. Make up water meter connection for control of inhibitor feed.
- C. One (1) Conductivity probe and flow switch, with dual carbon elements, potted in a PVC holder, mounted in a Schedule 80 PVC tee, complete with shut-off valves and probe fitting. The combination sensor shall be easily removed from the sensor fitting by loosening the lock nut. Electrical connections shall be by means of a 6-conductor cable, terminating in a quick-disconnect, self-locking connector. Connect to cooling water loop as shown on the drawing.
- D. One (1) water meter for installation into the make-up water line feeding the evaporative cooling tower. Size water meter for full load conditions. This meter shall send a pulse at 100 Gallons per contact. Wire to water treatment controller. Water Meter shall be AWWA constructed.
- E. One (1) pre-piped bleed-off piping assembly consisting of inlet shutoff valve, wye strainer, strainer flush valve, throttling valve and 0 PSI differential brass motorized ball valve with spring assist closing. Bleed-off piping assembly shall be sized to bleed twice the maximum design bleed-off rate of the system.

- F. One (1) Chemical feed pump for scale and corrosion inhibitor, positive displacement type with ball-type check valves for feed of biocide. Pumps shall be Grundfos model DDE 610B PP-E. Feed rate shall be adjustable while pump is running and necessary polyethylene discharge tubing included.
- G. Three (3) Corporation stop and injection assembly (3/4") with Kynar and Stainless Steel diffuser tubes and back check valve for injecting chemicals into recirculating line. Connect to cooling water loop as shown on the drawing. Chemical compatibility will dictate which diffuser to use.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prior to any work and the removal of system components, Contractor/current chemical treatment company shall take a chemical reading of existing system levels to establish new system chemical treatment to be matched.
- B. Install in accordance with manufacturer's instructions.

3.2 CLOSED SYSTEM TREATMENT

- A. Hot Water Closed Loop Systems:
 - 1. RLC shall provide the contractor with an on-site chemical test of the system raw feedwater, field test prior to addition of cleaner, field test after cleaning of systems – to be sure all cleaner, organic and inorganic matter has been removed, field test after straight DI water has been allowed to circulate within the closed loop systems for twenty-four hours.

3.3 PREOPERATIONAL SYSTEM CLEANOUT

- A. All 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 precleaner chemical products shall be added and circulated throughout the water system. The water system shall then be drained, refilled, and flushed thoroughly until no foreign matter is observed and the total alkalinity of the rinse water is equal to that of the make-up water.

3.4 WATER TREATMENT PROGRAM

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

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

3.5 PIPING AND WIRING

- A. Provide all necessary wiring and piping as required to connect to controls, piping, and power.

END OF SECTION 230545

SECTION 230570 – BOILER/BURNER

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. High Efficiency Gas Fired Boiler
- B. Flues (Direct Vent)
- C. Buffer Tank

1.2 REFERENCES

- A. AGA Z21.13 - Gas-Fired Low-Pressure Steam and Hot Water Boilers
- B. ASME SEC 4 - Boiler and Pressure Vessel Codes - Rules for Construction of Heating Boilers
- C. ASME SEC 8D - Boiler and Pressure Vessel Codes - Rules for Construction of Pressure Vessels
- D. HI (Hydronics Institute) - Testing and Rating Standard for Cast Iron and Steel Heating Boilers
- E. NFPA 54 (AGA Z223.1) - National Fuel Gas Code
- F. NFPA 70 - National Electrical Code

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 23 00 10.
- B. Product Data: Provide data indicating dimension, ratings, capacity, weight, general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.

1.4 REGULATORY REQUIREMENTS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. This specification is based on the Benchmark Series boilers that are fitted with Edge [ii] control as manufactured by AERCO International Inc. Equivalent units and manufacturers must meet all performance criteria, and will be considered upon prior approval.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide AERCO International, Benchmark Series Boiler with Edge [ii] control:
1. BMK 6000 (6,000,000 BTU/hr input)
 2. Approved Equals:
 - a. AERCO Benchmark boilers w/Edge [i] Controls
 - b. AERCO MFC Series
 - c. Request for substitutions will be considered in accordance with provisions of Section 235216 - Condensing Boilers, in writing no less than 30 days prior to bid date.
 - d. Note: Water tube boilers are not permitted without written approval. Request and written approval must be submitted and obtained 14 days prior to bid date.

2.2 CONSTRUCTION

- A. Description: Boiler shall be either natural gas, propane or dual fuel fired (nat. gas/propane) fully condensing fire tube design. It shall be design to operate in variable primary or primary secondary piping configuration. Power burner shall have full modulation, discharge into a positive or negative pressure vent and the minimum firing rate shall not exceed the following per model:

- BMK6000: 400,000 BTU/hr input

Boilers that have an input greater than what is specified above at minimum fire will not be considered. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent, combustion-air intake connections, water supply, return and condensate drain connections and controls.

- B. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 1/2" or 5/8" OD, with no less than 0.049" wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8 inch diameter.
- C. Pressure Vessel: The pressure vessel shall have a maximum water volume per each model as listed below:

- BMK6000: 110 gallons (416.4 liters)

The boiler water pressure drop shall not exceed the following per model size:

- BMK6000: 4psig @500 gpm

The boiler water connections shall be flanged 150-pound, ANSI rated.

- BMK6000: 6 inch flange

The pressure vessel shall be constructed of ASME SA53 carbon steel, with a 0.25-inch-thick wall and 0.50 inch thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

- D. Dual Returns: The boiler shall include dual return connections for low and high return temperature zones for added flexibility and thermal efficiency optimization. The boiler shall not have a minimum flow rate requirement through either return connection as long as the specified minimum flow of the boiler is met through a combination of the two return connections. Boilers with single return will be deemed unacceptable.
- E. Modulating Air/Fuel Valve and Burner: The boiler burner shall be capable of the following firing turndown ratios without loss of combustion efficiency or staging of gas valves. The turndown ratios shall be as follows and are based on BTU size:

- BMK6000: 15:1

The burner shall not operate above 7.5% oxygen level or 55% excess air. The burner shall produce less than 13 ppm of NO_x, under standard calibration, corrected to 3% excess oxygen when firing on natural gas. The burner shall be metal-fiber mesh covering a stainless-steel body with spark or proven pilot ignition and flame rectification. All burner material exposed to the combustion zone shall be 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. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable speed cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

- F. Fuel: The boiler shall use one of the following gas train options:
1. Natural gas or propane: The unit gas train shall be specifically designed and calibrated for a single predetermined fuel. The gas train shall be a ventless gas train.
 2. Dual Fuel Capability. Dual fuel boiler (natural gas/propane) shall include a combustion system capable of operating on both Natural Gas and Propane. The boiler efficiency and turndown shall remain unchanged regardless of fuel source. The dual fuel system shall incorporate independent natural gas and propane gas trains and a fuel selector switch. This switching mechanism shall be such that it shall not be possible to flow both fuels simultaneously. The unit shall be calibrated to run on both fuel sources at start-up. No additional re-calibration shall be required when switching between fuel sources for a period of one year from the initial calibration.

- G. Minimum boiler efficiencies shall be as follows at a 20°F delta-T:

EWT	100% Fire	50% Fire	7% Fire
160 °F	86.5%	87%	87%
140 °F	87%	87.5%	87.5%
120 °F	88.5%	89%	90%
100 °F	93.2%	94.5%	95.2%
80 °F	95.6%	96.8%	98.2%

- H. Exhaust Manifold: The exhaust manifold shall be of corrosion resistant cast aluminum or 316 stainless-steel with the following diameter flue connections:

- BMK6000: 12-inch (<20 ppm NO_x) or 14-inch (<9 ppm NO_x)

The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.

- I. Blower: The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.
1. Motors: Blower motors shall comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require a motor to operate in the service factor range above 1.0.
- J. Ignition: Ignition shall be via spark or proven pilot ignition with 100 percent main-valve shutoff and electronic flame supervision.
- K. Combustion Air: The boiler shall be designed such that the combustion air is drawn from the inside of the boiler enclosure, decoupling it from the combustion air supply and preheating the air to increase efficiency.
- L. Combustion Air Filter: The boiler shall be equipped with an automotive high flow air filter to ensure efficient combustion and unhindered burner components operation.
- M. Enclosure: The plastic and sheet metal enclosure shall be fully removable, allowing for easy access during servicing.
- N. O₂ sensor located in the Combustion Chamber: The boiler shall be equipped with an Oxygen sensor. The sensor shall be located in the boiler combustion chamber. Boilers without Oxygen sensor or boilers with an Oxygen sensor in the exhaust shall not be acceptable due to measurement estimation and performance accuracy.

2.3 CONTROLS

- A. The boiler shall have an integrated boiler control that is capable of operating the boiler and associated accessories including but not limited to: its pumps, valves and dampers.
 - 1. The control shall have a 5-inch color touch screen display as well as six function buttons that are separate from the display. User shall have the ability to navigate the menus via touchscreen or navigation buttons. Controls not equipped with navigation button options shall not be permitted.
 - 2. The control shall be equipped with a multi-color linear LED light to indicate the level of firing and/or air/fuel valve position.
 - 3. The control shall display two temperatures using two dedicated three-digit seven-segment displays.
 - 4. The control shall offer an Enable/Disable toggle switch as well as two buttons for Testing and Resetting the Low Water Cutoff.
- B. The Manager designated boiler control shall be capable of the following functions without the need for additional external controls:
 - 1. Sequence up to 16 boilers,
 - 2. Control boiler variable speed or single speed pumps and/or modulating motorized valves,
 - 3. Operate or modulate a variable or single speed system pump or rotate two system pumps,
 - 4. Control and communicate with up to 6 SmartPlate domestic water heaters and their domestic hot water pump,
 - 5. The control shall connect to other plant boiler controls using RS485 and communicate using BACnet protocol.
- C. The control system shall be segregated into three components: "Edge [ii]" Control Panel, Power Panel and Input/Output Connection Box. The entire system shall be Underwriters Laboratories recognized.
- D. The control panel shall consist of seven individual circuit boards using surface-mount technology in a single enclosure. Each board shall be individually field replaceable. These circuit boards shall include:
 - 1. A microcontroller board with integrated 5 inch touchscreen color display providing the user interface.
 - 2. A 7-segment display board. This board includes two 3-digit 7-segment displays. These displays shall be used to view a variety of temperature sensor values and operating and startup function status.
 - 3. An Interface board connects the microcontroller board to internal components using ribbon cables.
 - 4. An electric low-water cutoff board connects to the test and manual reset functions on the microcontroller board.
 - 5. A power supply board is designed to provide the different DC voltages to the rest of the boards. It also acts as voltage regulator and reduce power noise.
 - 6. An ignition and combustion board. This board controls the air/fuel valve and Safety Shutoff Valve, flame status and ignition transformer
 - 7. A connector board used to connect all external electrical connection.
- E. Combination plant: The managing boiler control shall be capable of setting and managing a combination plant that consist of up to two groups of boilers, their swing boilers and swing valves.

The control shall be capable of performing all the listed features without the need for any additional controls. The use of additional controls to achieve any of these functionalities shall be prohibited to simplify installation and plant management. The combination plant control shall have the following capabilities:

1. The control shall operate one group of boilers for heating and another group of boilers for domestic hot water using plate heat exchangers or indirect tanks.
 2. The control shall manage and rotate the lead boiler in each of the two groups independent of the other group.
 3. The control shall be capable of managing one or two swing boilers and their motorized swing valves to direct the output of the swing boiler(s) to one of the two groups based on the plant priority settings. The control shall also connect to the header and return sensors for each of the two groups of boilers and use those values to manage the set point for each group.
 4. The control shall offer two independent logics that run simultaneously managing each group of boilers. Each boiler group logic shall have its temperature values, setpoints, PID and feedback parameters that is independent of the other group settings and parameters.
- F. System Pump lead/lag rotation: The control shall be capable of operating two system pumps. It shall rotate the lead pump based on user time setting. The use of an external pump lead-lag control shall not be permitted unless function is performed by building management system.
- G. Variable Speed Pump: The control shall be capable of modulating a variable speed pump. It shall modulate the pump based on the boiler firing rate, the boiler plant firing rate, or based on the return header temperature differential from supply water temperature on a primary secondary piping application.
- H. Minimum number of boiler plant open valves: The control shall manage the minimum number of boiler motorized valves to reduce variable speed pump flow and energy used. The control shall offer a setting to control the number of valves open during low load and standby operation. Manufacturers without this feature shall offer additional pump controller and a smaller single speed pump to run during the low load and standby periods.
- I. Control settings transfer using USB: The control shall simplify and significantly lessen startup and boiler setting time by being able to use a USB flash drive to copy settings from one boiler to another boiler. Installers shall use successfully preconfigured boiler settings in their portfolio to newly installed boilers.
- J. Combustion calibration: The control shall offer at least 5 calibration points. The use of less than 5 calibration points is not permitted to improve overall system efficiency under all firing rates. Each combustion calibration point shall operate with 5 to 7% O₂ levels to improve operating efficiency. Deviating away from these values shall not be acceptable.
- K. Assisted Combustion Calibration: The control shall offer an assisted combustion calibration feature to help reduce setup time and improve setup accuracy. The assisted combustion calibration shall adjust the O₂ level at each calibration point to help keep O₂ level within allowable efficiency. The control shall log, date and time stamp the calibrated point combustion values of O₂ and allow the user to log NO_x, CO and flame strength. The control shall check these values against manufacturer allowable combustion values and color identify values out of manufacturer acceptable ranges. As

an additional capability, the control shall also have the ability to perform manual combustion calibration. Not having Assisted Combustion Calibration function shall be prohibited.

- L. Valve Balancing: To help simplify installation and as part of a boiler plant, the control shall be capable of controlling an electronic modulating motorized valve for each of the boilers using the manager boiler control. It shall have a built-in logic to provide a maximum flow using an adjustable valve opening percentage point for each boiler. The control shall be capable of closing any valve that has an off boiler. If all boilers are off, the control shall keep at minimum one valve open to protect pumps.
- M. Building Automation: The control shall be able to communicate to Building Management Systems using BACnet without the use of external gateways. The control shall be able to communicate over each of the two protocols using IP as well as RS485. The use of external gateways is not acceptable. The control shall be able to communicate to the building management system using:
 - 1. BACnet MS/TP and BACnet IP/Ethernet. When communicating over BACnet IP, the control shall offer an additional layer of IP security by mapping all control BACnet IP communication to the BACnet server's IP and MAC addresses. Not having this level of security shall deem the IP communication insecure and shall not be acceptable.
- N. Unit and Plant Status: The control shall provide a quick view of the unit status and plant status.
 - 1. The unit status screen shall provide temperature setpoint, all water inlet and outlet and supply air and exhaust temperature sensors values. It shall also provide unit current and target firing rates. Additional screens shall display unit run hours, cycle count and average cycles per hour.
 - 2. The plant status screens shall provide plant temperature setpoint, plant water supply and return temperatures, outdoor temperature and domestic hot water setpoint and current temperatures. Additionally, a status screen shall show the boiler status of each plant unit, plant firing rate.
 - 3. Unit and Plant event history: The manager control shall display the last 500 historical events per plant or 200 historical events for single unit installations.
- O. Software update: The control shall be capable of field software updates without a need for hardware component(s) replacement. This shall be performed either using software on a USB flash drive or via Internet connection. The software update mechanism shall be performed by a trained technician. The software update menus shall be secured using a password level. After the software update, the control shall retain all of its prior field settings.
- P. Copy settings from one boiler to the other: To significantly reduce installation time by reducing long repetitive work, the control shall have the capability of saving its settings to a USB flash drive. In addition, the control shall have the ability of copying new settings from a flash drive.
- Q. Programmable Inputs and Outputs: The control shall be equipped with multiple relay and analog outputs and dry contact and analog inputs. Each shall be field programmable to meet installation needs. The following I/O options shall be available:
 - 1. Relay Outputs: There shall be two output relays that are programmable. The following relay functions shall be selectable:
 - a. Swing Valve 2
 - b. System Pump
 - c. Summer Pump

- d. Multi-Temperature Pump
 - e. Pump2
 - f. Louver
- 2. Inputs and interlocks: The following control functions shall be available:
 - a. Flow input
 - b. Damper end switch input
 - c. Louver end switch input
- 3. Analog Output: There shall be three analog outputs that are programmable. The control shall have configurable analog outputs that can be used as one of the following options:
 - a. Boiler Pump
 - b. Domestic hot water variable speed pump
 - c. Valve
 - d. Fire rate
- 4. Analog input: There shall be three analog inputs that are programmable. The control shall have configurable analog inputs that can be used as one of the following options:
 - a. Remote setpoint
 - b. Smart Plate valve position
 - c. Domestic hot water variable speed pump flow
- R. Backup boiler: The control shall be able to operate a lower efficiency back up boiler during peak periods when main plant boilers are at or close to peak load.
- S. Communication with SmartPlate: The control shall be capable of controlling and monitoring one or multiple plate heat exchanger(s). It shall be able to:
 - 1. Change the domestic hot water temperature setpoint and read its current temperatures.
 - 2. Monitor 3-way valve position.
 - 3. Control the operation of the domestic hot water pump.
- T. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities.
- U. The control panel shall incorporate:
 - 1. Setpoint High Limit: Setpoint high limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable band from the desired maximum boiler outlet temperature.
 - 2. Setpoint Low Limit: Allow for a selectable minimum operating temperature.
 - 3. Failsafe Mode: Failsafe mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the control can to shut off the unit upon loss of external signal, if so desired.
- V. The boiler control system shall incorporate the following additional features for enhanced external system interface:
 - 1. System start temperature feature
 - 2. Pump delay timer
 - 3. Auxiliary start delay timer
 - 4. Auxiliary temperature sensor

5. Analog output feature to enable simple monitoring of temperature setpoint, outlet temperature or fire rate
 6. Remote interlock circuit
 7. Delayed interlock circuit
 8. Easy Setup by providing simplified menu quick settings to expedite plant and boiler setup
 9. Delta-T Limiter
 10. Freeze protection
 11. Fault relay for remote fault alarm
 12. Warm-weather shutdown
 13. The control shall offer multi-level user security access using different passwords. For additional security, the passwords shall expire if control display was not touched for an extended period 30 minutes.
- W. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD 1.
- X. O₂-Trim or AERtrim: Each boiler shall be equipped with the patented AERtrim system, an advanced O₂-trim system for condensing boiler applications. The system shall utilize a low cost reliable automotive O₂ sensor that measures and monitors the oxygen content of the exhaust gases. The system shall adjust the blower speed to maintain optimal air-fuel ratios in the event of any site condition changes (air density, gas pressure, BTU content, etc.). The system shall have the following capabilities:
1. Self-Diagnostics
 - a. System Status and Error Messages
 - b. When excessive trimming is occurring
 - c. When O₂ sensor has fallen out of calibration
 2. Adjustable parameter settings
 - a. O₂ target and range to meet site requirements
 - b. Schedule daily or weekly self-diagnostics

Output of O₂ information shall be displayed on the Edge [ii] control panel.

The O₂ sensor shall be installed through the unit's burner plate and measure the oxygen content directly within the unit's combustion chamber.

Boilers without an equivalent O₂ trim will be deemed unacceptable. Due to the moisture content of flue gases from condensing boilers, placing the O₂ sensor in the exhaust manifold or stack will be deemed unacceptable.

Boilers which require their O₂ sensor be changed annually will be deemed unacceptable.

- Y. Each boiler shall be onAER ready with a standard Ethernet port and include a 5 year onAER subscription at no additional charge. AERCO's onAER service grants the user online access to real time operation and status of their system plant from any computer, tablet or mobile device along with the following capabilities:
1. Efficiency status and trends
 2. O₂ Levels
 3. Efficiency and performance optimization tips

4. Preventative Maintenance alerts and scheduling
5. Predictive Maintenance algorithms
6. Warning and error messages
7. Weekly or monthly performance and status reports
8. Manage multiple boiler plants or buildings
9. Customizable dashboard
10. Add email contacts for alerts and reports, including local AERCO trained technicians
11. Manage and store startup, maintenance and service documentation

The boiler manufacturer shall be able to provide a network hub or a network switch to connect up to 16 boilers to an online network.

- Z. Each boiler shall have integrated Boiler Sequencing Technology (BST), capable of multi-unit sequencing with lead-lag functionality and parallel operation. The system will incorporate the following capabilities:
1. Efficiently sequence 2-to-16 units on the same system to meet load requirement.
 2. Integrated control and wiring for seamless installation of optional modulating motorized valve. When valves are utilized, the system shall operate one motorized valve per unit as an element of load sequencing. Valves shall close with decreased load as units turn off, with all valves open under no-load conditions.
 3. Automatically rotate lead/lag amongst the units on the chain and monitor run hours per unit and balance load in an effort to equalize run hours among active units.
 4. Option to manually designate lead and last boiler
 5. Designated manager control, used to display and adjust key system parameters.
 6. Automatic bump-less transfer of master function to next unit on the chain in case of designated master unit failure; master/slave status shall be shown on the individual unit displays.
- AA. For boiler plants greater than 16 units, the Boiler Manufacturer shall supply as part of the boiler package a completely integrated AERCO Control System (ACS) to control all operation and energy input of the multiple boiler heating plant. The ACS shall be comprised of a microprocessor based control utilizing the BACnet protocol to communicate with the Boilers via the RS-485 port. One ACS controller shall have the ability to operate up to 32 AERCO boilers.

The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The ACS shall control the boiler outlet header temperature within $\pm 2^{\circ}\text{F}$. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The ACS controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.

The ACS shall have the following anti-cycling features:

- Manual designation of lead boiler and last boiler.
- Lead boiler rotation at user-specified time interval.
- Delay the firing/shutting down of boilers when header temperature within a predefined dead band.

When set on Internal Setpoint Mode, temperature control setpoint on the ACS shall be fully field

adjustable from 50°F to 190°F in operation. When set on Indoor/Outdoor Reset Mode, the ACS will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. When set on 4ma to 20ma Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied.

When set on BACnet Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint as an external communication utilizing the BACnet protocol is supplied via the RS-232 port. The ACS controller shall have a vacuum fluorescent display for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided as standard. The controller will automatically balance the sequence of operating time on each boiler by a first-on first-off mode and provide for setback and remote alarm contacts. Connection between central ACS system and individual boilers shall be twisted pair low voltage wiring, with the boilers 'daisy-chained' for ease of installation.

2.4 ELECTRICAL POWER

- A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
- B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.
- C. Electrical Characteristics:

Electrical Specifications	Models
	BMK2500-6000
Voltage	460 V
Phase	3
Frequency	60 Hz
Full Load Current	5-12 Amps

2.5 VENTING

- A. The boiler shall be capable of venting in Polypropylene venting material. The exhaust vent must be UL Listed for use with Category II, III and IV appliances and compatible with condensing flue gas service. UL listed vents of Polypropylene or AI 29-4C stainless steel must be used with boilers.
 - PVC/CPVC is approved for use with BMK750 and 1000 models
- B. The minimum exhaust vent duct size for each boiler is 12 inch (BMK6000) diameter.

- C. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a metal or PVC duct connected between the boiler and the outdoors.
- D. The minimum ducted combustion air duct size for each boiler is 12 inch (BMK6000) diameter.
- E. Common vent and common combustion air must be an available option for boiler installation. To improve system efficiency, multi-boiler system shall utilize sequencing logic with common venting as well as individual boiler venting configuration. Manufacturers not allowing parallel modulation for common shall not be acceptable. Consult manufacturer for common vent and combustion air sizing.
- F. Follow guidelines specified in manufacturer's venting guide.

2.6 SOURCE QUALITY CONTROL

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

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54.
- C. Install boiler on new concrete housekeeping base, sized minimum 4" larger than boiler base.
- D. Provide connection of natural gas service in accordance with NFPA 54 (AGA Z223.1).
- E. Provide piping connections and accessories as indicated
- F. Provide flue connections and accessories as indicated.
- G. Pipe relief valves to outside.
- H. Provide for connection to electrical service.

- I. Boiler manufacturer shall provide Factory Start-up and Commissioning for Boilers – This cost shall be included in the Mechanical Contractors Bid.

END OF SECTION 230570

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

- Building Automation System
- Packaged Rooftop Air Handling Units
- Hot Water Duct Coils
- Circulating Pumps
- Fan Coils
- Fan Powered VAV Boxes
- VAV Boxes
- Mini-Split System Units
- Exhaust Fans
- Cabinet Heaters, Unit Heaters, and Baseboard Heaters
- Make-Up Air Unit
- Split System Air Handling Units (Alt Bid)
- Boilers

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 Unit Heaters
- B. Fan Powered VAV Boxes
- C. Mini-Split System Air Conditioner System
- D. Hot Water Duct Coils
- E. Single Duct VAV Boxes

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: HYDRONIC UNITS

- A. Base Bid: Trane
- B. Alternate Bid
 - 1. JCI/York
 - 2. Modine
 - 3. Sigma
 - 4. Sterling
 - 5. Rittling

2.2 CABINET UNIT HEATERS

- A. Furnish and install where indicated on the drawings, horizontal recessed, vertical recessed or

vertical cabinet 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. Units shall be "Force-Flo" Model E (horizontal recessed), Model H (vertical recessed), Model F (vertical cabinet) or Model D (horizontal cabinet) as manufactured by Trane, American Air Filter or equal.

- B. Vertical Cabinet Models - Unit shall have 18-ga steel panels, bottom and end panels with channel-formed edges around entire panel perimeter, stamped outlet grilles with 15° downward deflection, stamped lattice inlet grilles, and bottom panel hinged at front and camlocked at back.
- C. Horizontal or Vertical 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 and enamel finished in a custom color selected by the Architect. Access door 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 VAV BOXES

- A. Manufacturers:
 - 1. Base Bid: Trane – Basis of Design
 - 2. Alternate Bid
 - a. Johnson Controls, Inc.
 - b. Carrier
 - c. Price
- B. Single Duct Terminal Units
 - 1. Ceiling mounted primary air control terminal units for connection to a single 5-in. w.g. maximum pressure duct of a central air distribution system. Terminal units may be provided with controls and integral heating coils.
 - 2. Identify each terminal unit with clearly marked identification label and airflow indicator. Label shall include unit nominal air flow, maximum factory-set air flow, minimum gactory-set air flow, and coil type.
- C. Fabrication
 - 1. Casings: Units shall be completely factory-assembled, manufactured of corrosion protected steel, and fabricated with a minimum of 18-gauge metal on the high pressure (inlet) side of the terminal unit damper and 22-gauge metal on the low pressure (outlet) side and unit casing.
 - 2. Insulation: Foil Faced - The interior surface of unit casing is acoustically and thermally

lined with a minimum of 1-inch, 1.0 lb/ft³ (25.4 mm, 16.0 kg/m³) density glass fiber with foil facing. Minimum insulation R-Value of 3.85. The interior foil liner shall isolate the fiberglass insulation from the airstream and allow for cleaning of the terminal unit interior surfaces. Insulation shall meet NFPA-90A, UL 181 and bacteriological standard ASTM C 665. The cut edges on the discharge of the unit shall be covered by a metal flange. There are no exposed edges of insulation (complete metal encapsulation).

3. Assembly: Primary air control damper, airflow sensor, controls and optional heating coil in single assembly.
4. Rectangular Supply Air Outlet Connections: Rectangular outlet connections for units without optional heating coils on the outlet of the terminal unit shall be flange type. Rectangular outlet connections for units with optional heating coils on the outlet of the terminal unit shall be slip and drive type.

D. Primary Air Control Damper Assembly

1. Construct damper assembly from a minimum of 18-gauge galvanized steel on the primary air side of the terminal. Blade shall incorporate a full closed cell damper seal to minimize leakage. Damper blade shall be a minimum of 0.10 in. thickness. Maximum damper leak rate shall not exceed 1% of damper nominal CFM at 4 in. w.g. differential pressure.
2. Damper assembly shall be constructed self-lubricating bearings and contain a mechanical stop.
3. Primary Damper Shaft shall have a position indicator stamped on the end of the shaft to identify damper position without disassembly of duct, unit casing, or removal of the control box cover.
4. Provide damper assembly with integral flow sensor. Flow sensor shall be provided regardless of control type. Flow sensor shall be a 16-point (minimum 8-points on high pressure side and 8-points on low pressure side), averaging ring or cross type. Bar or single point sensing type is not acceptable. Damper assembly shall be capable of maintaining airflow to within +/- 5 percent of rated unit airflow setpoint with 1.5 duct diameters straight duct upstream from the unit.
5. Flow sensor transducer shall not be integral to the unit controller.
6. Flow coefficient calibration data shall be provided for each terminal unit at or near the unit inlet.
7. Integral flow sensor pressure transducer shall be pressure tested, with air, prior field installation.

E. Heating Coils

1. Coils shall be factory-installed on the unit discharge and shall consist of aluminum plated fins and seamless copper tubes. Coils shall be constructed with 144 aluminum-plated fins per foot (.305 m). Fins shall have full fin collars to provide accurate fin spacing and maximum fin-to-tube contact. The 3/8 inch (9.5 mm) OD tubes shall be mechanically expanded into the fin collars and casing sides. Coils shall be leak tested at 300 psig (2068 kPa) air pressure under water and proof tested under water to 450 psig (3102 kPa) pressure or equivalent tracer gas testing. Supply and return water connections shall be on the same side of the coil and independent of handing to allow jobsite determination of handing. Coil connections shall be brazed. Coil shall have gasketed access panels, on the top and bottom attached with screws suitable for cleaning the inlet and outlet coil faces without disconnecting the coil from the main unit.
2. Capacity: Provide coils in capacities as scheduled on the drawings.

F. Controls

1. Terminal interface shall be provided for use with a field supplied third-party controller.
2. The control box shall contain a relay board which includes **a 120 volt** to 24-volt transformer, quite contactors (for electric heat units), and an optional disconnect switch. All end devices shall be wired to allow voltage terminal block and run-tested, only a power connection and/or thermostat connection is needed to commission the unit.
3. When normally open valves are selected, inverting relays shall be provided for use with standard thermostats.

G. Wiring

1. Factory install and wire terminal unit. Install electrical components in control box with removable cover. Incorporate single point electrical connection to power source.
2. Disconnect Switch: Provide terminal units with a factory-installed and wired switch to disconnect power to the unit.

H. Testing/Verification

1. Maximum Casing Leakage: 1 percent of nominal air flow at 0.5 in w.g. inlet static pressure.
2. Maximum Damper Leakage: 1 percent of design air flow at 4 in w.g. inlet static pressure.

2.4 MINI-SPLIT SYSTEM AIR CONDITIONER SYSTEM (AC/CU)

A. Basis of Design: Mitsubishi

B. Accepted Substitutes:

1. Carrier
2. York

C. Provide split system cassette air conditioning unit(s).

D. Indoor unit shall be wall hung as indicated on drawings, painted in custom color selected by the Architect and shall include thermostat and condensate pump.

E. Outdoor unit shall include all standard equipment and controls, low ambient controls, hard start, anti-short cycle timer and voltage as shown on the plans.

F. Furnish unit with 5-year warranty for all material, labor, and refrigerant.

G. Unit shall include low ambient control for operation down to 0°F.

H. Furnish and install with condensate pump and wall mounted thermostat.

I. Furnish with Thermostat Interface for integration to Building Automation System (BAS).

2.5 HOT WATER DUCT COILS

A. Hot water coils shall be installed in supply duct as indicated on drawings. Hot water coils shall be Trane Type WC or approved equal by Carrier or York, with aluminum plate fins mechanically

bonded to copper tubes. Coils shall be galvanized steel casing and shall be mounted pitched for drainage. Coil shall be tested at 300-psig for proof test, 200-psig for leak test.

2.6 FAN POWERED VAV BOXES (FPV)

- A. Manufacturers:
 - 1. Base Bid: Trane – Basis of Design
 - 2. Alternate Bid
 - a. Johnson Controls, Inc.
 - b. Carrier
 - c. Price
- B. General: Units shall be ETL listed. Terminals shall include a single point electrical connection. Terminal units shall be AHRI certified and bear the AHRI 880 seal. 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: Terminals shall be constructed of not less than 20-ga galvanized steel, able to withstand a 125-hour salt spray test per ASTM B-117. Casing shall be internally lined with 1/2" thick fiberglass insulation, rated for a maximum air velocity of 5000 f.p.m. Maximum thermal conductivity shall be .24 (BTU • in) / (hr • ft² • °F). The interior surface of the unit is acoustically and thermally lined with 1", 1.5 lb/cu. ft density glass fiber with a foil facing. The insulation is UL listed and meets NFPA-90A, UL 181 standards, and bacteriological standard ASTM C 665. All insulation options which meet the 25/50 smoke developed and flame spread rating (per ASTM E 84 and UL 723 and CAN/ULC S102-M88) meets NFPA-90B. The insulation R-value is 4.1. All cut edges of insulation are completely encapsulated in metal to prevent erosion. Casing shall have top and 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. Multiple discharge openings are not acceptable. All appurtenances including control assemblies, control enclosures, and hot water 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: Rectangular shaped primary air valves shall consist of minimum 18-ga galvanized steel. Cylindrically shaped primary air valves shall consist of minimum 22-ga galvanized steel and include 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 self-lubricating 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 for cylindrical valves. Rectangular valve leakage shall not exceed 2% of maximum inlet rated airflow at 3" W.G. inlet pressure.

- F. Primary Airflow Sensor: Differential pressure airflow sensor shall traverse the duct 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. Balancing taps shall be provided for field airflow measurements.
- G. Fan Assembly: The unit fan shall utilize a forward curved, dynamically balanced, galvanized wheel with a direct drive motor. The fan motor shall be unpluggable 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.
- H. Hot Water Coil: Terminal shall include an integral hot water coil where indicated on the plans. The coil shall be manufactured by the terminal unit manufacturer and shall have a minimum 22-ga galvanized sheet metal casing. Stainless steel casings, or galvanized steel casings may be used as an alternative. Coil to be constructed of pure aluminum fins with full fin collars to assure accurate fin spacing and maximum tube contact. Fins shall be spaced with a minimum of 10 per inch and mechanically fixed to seamless copper tubes for maximum heat transfer. Each coil shall be hydrostatically tested at 450-psig under water and rated for a maximum 300-psig working pressure at 200°F. Coils shall incorporate a built in, flush mounted access plate, allowing top and bottom access to coil.
- I. Options:
 - 1. Filters: Terminals shall include a filter rack and 1" thick disposable fiberglass filter, allowing removal without horizontal sliding.
 - 2. ECM Fan Motor: Fan motor shall be ECM. Motor shall be brushless DC controlled by an integral controller / inverter that operates the wound stator and senses rotor position to electronically commutate the stator. Motor shall be permanent magnet type with near-zero rotor losses designed for synchronous rotation. The motor shall utilize permanently lubricated ball bearings. Motor shall maintain minimum 70% efficiency over the entire operating range. Motor speed control shall be accomplished through a PWM (pulse width modulation) controller specifically designed for compatibility with the ECM. The speed controller shall have terminals for field verification of fan capacity utilizing a digital voltmeter. A calibration graph shall be supplied indicating Fan CFM verses DC Volts.
- J. Furnish Controls Enclosure with 120V to control voltage transformer.

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. Custom color to be selected by the Architect.
- C. Install convectors and cabinet heaters as indicated. Coordinate to assure correct recess size for recessed convectors. Exposed surface custom color to be selected by the Architect.
- D. Locate unit ventilators as indicated, level and shim units, and anchor to structure. Coordinate exact location of wall louvers. Seal airtight around connection of unit vent/falseback to wall louvers. Custom color to be selected by the Architect.
- E. 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.

END OF SECTION 230835

SECTION 230855 - AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Packaged Rooftop Unit
- B. Vertical Split System Air Handling Units (Alt Bid)
- C. Fan Coils

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 PACKAGED ROOFTOP UNITS (DX)

- A. The contractor shall furnish and install packaged unit(s) as shown and scheduled on the contract documents. The unit(s) shall be installed in accordance with his specification and perform at the specified conditions as scheduled.
- B. Base Bid: Trane Horizon Model OAV (Basis of Design)
 - 1. Alternate Bid
 - a. Johnson Controls, Inc.
 - b. Greenheck
- C. Unit:
 - 1. Furnish and install packaged unit as scheduled on contract documents and described in these specifications. Unit shall be designed for cooling and/or heating. Compressor controls shall modulate capacity to maintain evaporator leaving set point. Hot Gas Bypass shall not be used to control compressor capacity. Heating system shall include modulating controls. Compressor on-off only or primary heating on-off only controls shall not be acceptable control strategies. Unit shall include hot gas reheat for space humidity control.
 - 2. Unit shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.
 - 3. Unit discharge airflow configuration shall be as shown on the plans.
- D. Construction:
 - 1. Cabinet panels: 2" double-wall foamed panel construction throughout the indoor section of unit to provide nonporous, cleanable interior surfaces. All interior seams exposed to airflow shall be sealed.
 - 2. Insulation: 2" polyisocyanurate foam metal encapsulated with no exposed edges. Initial R value of 6.6 per inch of thickness.
 - 3. Cabinet base shall be double wall construction designed to prevent trapping or ponding of water within the unit base. Cabinet base pan shall be insulated with 2" thick polyisocyanurate foam. Foam insulation shall be fully enclosed with galvanized steel insulation cover. Insulation shall not be applied to underside of unit base.
 - 4. Cabinet Base Rails: Side and end base rails shall include openings for forklift and tie-down access. To protect unit base from fork damage side rails shall include removable heavy gauge fork pockets.
 - 5. Shipping anchors attach to and/or through unit base rails. Straps over unit shall not be used to secure unit for shipping.

6. Cabinet material interior and base rails: shall be G-90 zinc-coated galvanized steel. Material gauge shall be a minimum of 14-gauge for base rails, 16-gauge for structural members and 20-gauge for access doors and cabinet panels.
 7. Exterior Corrosion Protection: Exterior cabinet panels shall be a base coat of G-90 galvanized steel with both exterior and interior surfaces cleaned, phosphatized, and finished with a weather-resistant baked enamel finish in custom color selected by the Architect. Unit's surface shall be in compliance with ASTM B45 salt spray testing at a minimum of 672-hour duration.
 8. Cabinet construction shall provide hinged panels providing easy access for all parts requiring routine service.
 9. Cabinet top cover shall be one piece construction or where seams exist, it shall be double-hemmed and gasket-sealed.
 10. Hinged Access Panels: Water- and air-tight hinged access panels shall provide access to all areas requiring routine service including air filters, heating section, electrical and control cabinet sections, optional ERV and power exhaust fan section, supply air fan section, evaporator and reheat coil sections. Insulated doors shall be constructed to allow the hinges to be reversed in the field.
 11. Hold-open devices shall be factory installed on all hinged access doors. Chains shall not be used as hold-open devices.
 12. Latches with locking hasp or tool operated closure devices shall be factory installed on all hinged access panels.
- E. Drain Pan
1. Material shall be Type 430 Stainless steel drain and constructed to sloped in two directions to ensure positive drainage with corners exposed to standing water and drain fittings welded liquid tight to prevent leaks. Pan shall have a minimum depth of 2". Base of drain pan shall be insulated with 1" thick foam insulation.
 2. Provide openings either on side of unit or thru the base for power, control, and gas connections.
- F. Air inlet hood shall be factory installed and shall not require field assembly. Hood shall include 2" thick removable aluminum mesh mist eliminators sized for a velocity not to exceed 500 FPM at maximum unit rated airflow. Service access shall be hinged and held in place with thumb latches that shall not require tools for service access.
- G. Unit shall be equipped with a 6" filter rack upstream of the evaporator. Frame shall be field-adjustable to match any filter combination specified in the following section.
- H. Unit shall include 2" MERV 8 filters.
- I. Dampers:
1. Unit shall include a motor operated outdoor air damper constructed of galvanized steel.
 2. Damper blades shall be air foil design with rubber edge seals designed not to exceed a 4 CFM/SQ FT leakage rate exceeding ASHRAE 90.1 damper leakage requirements.
 3. Damper actuator shall be factory mounted and wired sealed spring return and either two-position or fully modulating.
 4. Dampers air velocity shall not exceed 2000 fpm.

5. Return Air damper shall be of same material, construction, and leakage rate as outdoor air damper. Return air damper actuator shall be factory mounted and wired sealed spring fully modulating and operate based on outdoor air damper feedback signal to properly regulate RA airflow.

J. Airflow Measuring Device

1. Measurement device shall consist of one or more sensor probe assemblies and a single, remotely mounted, microprocessor-based transmitter. Each sensor probe assembly shall contain one or more independently wired sensor housings. The airflow and temperature readings calculated for each sensor housing shall be equally weighted and averaged by the transmitter prior to output. Pitot tubes and arrays are not acceptable. Vortex shedding flow meters are not acceptable.
2. Duct and Plenum Sensor Probe Assemblies
 - a. Each sensor housing shall be calibrated at a minimum of 16 airflow rates and have an accuracy of $\pm 2\%$ of reading over the entire operating airflow range. Each sensor housing shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
 - b. The number of sensor housings at each location shall comply with the manufacturer's requirements.
 - c. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location.
3. The transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics. Configuration settings and diagnostic shall be accessed through a pushbutton interface on the main circuit board. Airflow shall be field configurable to be displayed as a velocity or a volumetric rate.
4. The transmitter shall have a power switch and operate on 24 VAC (isolation not required). The transmitter shall use a switching power supply fused protected from transients and power surges.
5. The transmitter shall be capable of communication with the host controls using one of the following interface options:
 - a. Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire)
 - b. RS-485: Field selectable BACnet-MS/TP, ModBus-RTU and Johnson Controls N2 Bus
 - c. 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, ModBus-TCP, and TCP/IP
 - d. LonWorks Free Topology

K. Compressors:

1. All units shall have direct drive, scroll type compressors.
2. Digital Scroll Compressor on the lead circuit.
3. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage.
4. Internal overloads shall be provided with the scroll compressors.
5. Each compressor shall have a crankcase heater to minimize the amount of liquid refrigerant present in the oil sump during off cycles.
6. Each compressor shall be mounted on rubber vibration isolators, to reduce the transmission of noise.

7. Provide each unit with hermetically sealed refrigerant circuit(s) factory-supplied completely piped with liquid line filter-drier, liquid line charging port, suction and liquid line pressure ports, sight glass, and thermal expansion valve.
 8. Provide each circuit with automatic reset high and low pressure and high temperature switches for safety control.
- L. Coils:
1. Evaporator and Condenser coils shall be constructed with copper tubes mechanically bonded to configured aluminum plate fins.
 2. Coils shall be factory leak tested in accordance ANSI/ASHRAE 15-1992 at a minimum pressure of 500 PSIG.
 3. The condenser coil shall have a fin designed for ease of cleaning.
 4. Evaporator coil shall include (six / four) rows of cooling interlaced for superior sensible and latent cooling with a maximum of 12 FPI for ease of cleaning
- M. Condenser Section:
1. Outdoor Fans: Shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electro-plated motor mounting brackets.
 2. Fans shall be statically and dynamically balanced.
- N. Compressor Capacity Control:
1. Electronic Control: Compressor output capacity shall be controlled by the Main Control Module. (refer to unit control and sequence sections of this specification)
- O. Electrical:
1. All high voltage power components such as fuses, switches and contactors shall include a service personnel protection barrier or shall be a listed as touch-safe design.
 2. Field wiring access to be provided thru unit base into isolated enclosure with removable cover.
 3. Power wiring to be single point connection.
 4. Wiring internal to the unit shall be colored and numbered for identification.
 5. Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure.
 6. Factory wired main power disconnect and overcurrent device shall be rated for total unit connected power.
 7. Unit SCCR rating shall be a minimum of 5kA.
 8. Factory wired Voltage/Phase monitor shall be included as standard. In the event of any of the following, the units will be shut down and a fault code will be stored in the monitor for the most recent 25 faults. Upon correction of the fault condition the unit will reset and restart automatically.
 9. Phase Unbalance Protection: Factory set 2%
 10. Over/Under/Brown Out Voltage Protection: +/-10% of nameplate voltage
 11. Phase Loss/Reversal
 12. Factory to mount and wire 120 volt convenience outlet. Field wiring of convenience outlet not acceptable.
 13. All low voltage field wiring connections shall be made at factory installed low voltage terminal strip.
- P. Controls:

1. Control of the units shall be by the ATC Contractor. Unit manufacturer shall provide terminal strip and any required interface. Coordinate protocol with the ATC manufacturer and installer. Provide all interfaces.
2. Refer to Section 23 09 00 for control and point requirements.
3. Provide full interface to alarms.
4. System Sensors shall include Factory installed and wired Outdoor Air Temperature, Outdoor Air Humidity and Evaporator Leaving Air Temperature and factory furnished, field installed Discharge Air Temperature.
 - a. Economizer Option includes Return Air Temperature and Humidity sensor.
 - b. ERV Option includes exhaust air leaving temperature sensor.
 - c. Powered Exhaust with Economizer includes duct pressure sensor to be field installed.
5. System controls shall include:
6. Anti-cycle timing
7. Minimum compressor run/off times
8. Smoke Detectors to sense (Return Air / Discharge Air / Return and Discharge Air) streams shall be factory installed and wired.

Q. Exhaust:

1. Provide a factory installed power exhaust assembly that shall be designed to ventilate return air to atmosphere.
2. Plenum mounted direct drive airfoil design exhaust wheel material shall be heavy gauge aluminum, welded construction and rated for up to Class III speed/pressure performance. Factory install and wire fan motor to on-board Variable Frequency Drive. Belt-drive and/or forward curve plenums fans shall not be used.
3. Exhaust to discharge through gravity dampers located on each side of unit cabinet.

R. Energy recovery:

1. The rotor media shall be made of polymer, formed into a honeycomb structure to minimize pressure loss and avoid plugging. Paper, plastic, or fibrous media are not acceptable. The rotor media must be coated to resist corrosion. All surfaces must be coated with a non-migrating desiccant layer to ensure that adequate latent capacity is provided. The desiccant coating must be firmly bonded to the aluminum surface and will not be dislodged when challenged with high velocity air up to 5000 feet per minute. Products that lose desiccant when served with high velocity air are not acceptable. The cassette must be a slide out design for serviceability. The media shall be cleanable with low temperature steam, hot water, or light detergent without degrading the latent recovery.
2. Sensible and latent recovery efficiencies must be clearly documented through a testing program conducted in accordance with ASHRAE Standard 84 and AHRI 1060. The testing must have been conducted by a qualified independent organization. The performance test reports must be provided for engineering review as part of the submittals for this project.
3. The rotor design shall ensure laminar airflow to minimize parasitic pressure loss and to optimize the operating efficiency of the system fans. The pressure loss across the media shall be no greater than the scheduled pressure loss values. The energy wheel shall operate effectively up to 180°F.
4. The rotor media shall be permanent, with an anticipated life of 20 years. It must be tested in accordance with ASTM Standard E-84 and provide smoke and flame spread ratings of less than 25 and 50 as required by NFPA 90A and UL 1995. A copy of the ASTM E-84 test report confirming the method of test and results shall be provided with the submittal. Heat

recovery wheels incorporating “throw-away” media and tested to UL900 for Class 2 filters are not acceptable.

5. The wheel manufacturer must have been producing energy recovery wheels for a minimum of ten years.
6. The rotor shall be supplied with perimeter brush seals and face contact seals to minimize air leakage and wheel bypass.
7. The rotor media shall be supported by a structural aluminum hub and aluminum reinforcing spoke system. The rotor bearings must be greaseable and provide L10 life in excess of 20 years.
8. The cassette framework shall be made of galvanized steel to prevent corrosion.
9. The rotor must be driven by long-life polyurethane/polyester composite link belt system. The rotor/cassette shall be designed so that belt can be removed or serviced without the removal of the bearing. A 3 phase A/C gear motor shall be utilized to accommodate variable speed applications.

S. Curb:

1. Contractor shall provide factory supplied 14" tall roof curb, 18-ga perimeter made of zinc coated steel with supply and return air gasketing and wood nailer strips. Ship knocked down and provided with instructions for easy assembly.
2. Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines.

2.2 VERTICAL SPLIT-SYSTEM AIR HANDLERS (Alt Bid)

A. Manufacturers

1. Trane – Basis of Design
2. Johnson Controls, Inc.
3. Carrier

B. Manufacturer must clearly define any exceptions made to Plans and Specifications. Any deviations in layout or arrangement shall be submitted to engineer prior to bid date for approval. Mechanical Contractor is responsible for expenses that occur due to exceptions made.

C. General Unit Description

1. Manufacturer shall provide unit arranged for draw-through application. Unit layout and configuration shall be as defined in project plans and schedule. Blow-through is only acceptable when consideration is given to capturing downstream moisture carryover. Considerations include downstream moisture eliminators and/or extended blank modules with condensate drain pans.

D. Unit Casing

1. The entire air handler shall be constructed of galvanized steel painted in custom color selected by the Architect. The removal of access panels shall not affect the structural integrity of the unit once the unit is installed. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.
2. Access panels shall be on front of the unit in all sections to allow easy access to drain pan, filter, coil(s), and motor components for cleaning, inspection, and maintenance.

3. Units shall each ship as fully assembled modules, including all coils, fans, motors, attenuators and filters.
4. Access Panels: Removable access panels shall be provided on front of the unit to facilitate service access to drain pans, motors, coil(s). Access panel for filter removal shall be provided on front of the unit.
5. Cabinet: Casing shall be manufactured of heavy gauge galvanized steel.

E. Insulation

1. High density, matte-faced – Interior surface of unit casing shall be acoustically (in single-wall modules) and thermally lined. Insulation shall have a minimum R-Value of 4 and shall be UL listed. The insulation shall comply with NFPA-90A and B, and UL191 requirements.

F. Coils

1. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.
2. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil are as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.
3. Construct coil casings of galvanized steel. End supports shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
4. Unit shall be furnished with a leak detection system from the factory when a circuit refrigerant charge exceeds 3.91 lbs. The leak detection system shall consist of one or more refrigerant detection sensors. When the system detects a leak, the unit controller shall initiate mitigation actions.
5. Refrigerant Cooling Coils
 - a. Refrigerant suction and liquid connections shall penetrate through unit casing to facilitate refrigerant piping in the field.
 - b. Coils shall be proof tested to 450 psig and leak tested to 300 psig air pressure under water. After testing, insides of tubes shall be air dried, charged with dry nitrogen or dry air, and sealed to prevent contamination.
 - c. Refrigerant suction and liquid headers shall be constructed of copper tubing. Suction and liquid connections shall penetrate unit casings to allow for sweat connections to refrigerant lines.
 - d. Tubes shall be 1/2 inch O.D., minimum .016 inch thick copper. Fins shall be aluminum.
 - e. Coils shall have equalizing type vertical distributors sized in conjunction with capacities of coils.

G. Drain Pan

1. Drain Pan(s) shall be constructed of corrosion resistant material. Acceptable materials include polymer or stainless steel. Units with cooling coils shall have drain pans under complete cooling coil section that extend beyond the air-leaving side of the coil to ensure capture of all condensate in section.

2. Drain pan manufacturer shall either insulate bottom of drain pan with closed cell foam or provide double wall internally insulated construction to eliminate bottom sweating.
 3. Drain pan shall be sloped in two planes, pitched toward drain connections to ensure complete condensate drainage when unit is installed level and trapped per manufacturer's installation instructions. Units without drain pans sloped in two planes shall coat drain pans with anti-microbial treatment.
 4. Drain pan(s) shall have a factory installed internal drain trap.
 5. Coil(s) shall be mounted above the drain pan to facilitate easy and complete inspection, cleaning, and removal. Coil(s) may not sit in drain pan.
- H. Fans
1. Provide single-wheel, dual-width, dual-inlet, forward curved centrifugal fans as specified on the schedule. All fans shall be dynamically balanced.
- I. Motors
1. All motors shall be factory-installed and run tested. To facilitate field replacement of motors, a removable fan inlet cone shall be provided on the drive side of the fan/motor assembly.
 2. Motor shall be ECM programmable type. The motor shall be preprogrammed in the factory to meet the specified airflow requirements.
 3. Fan motor shall have permanently lubricated and sealed bearings, protected by an internal thermal overload.
 4. Single phase motors shall be selected to operate continuously at 104 F (40 C) ambient without tripping on overloads. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.
 5. Manufacturer shall provide for each fan a nameplate with the following information to assist air balance contractor in start-up and services personnel in maintenance:
 - a. Fan motor part number
 - b. Fan design RPM and motor HP
 - c. Motor Full Load Amps
- J. Filters
1. Provide removable one- or two-inch-thick filters easily removable from front of the unit. All units shall use standard filter sizes.
- K. Controls
1. Fan motor and end devices shall be wired back to a control box enclosure. A junction box shall be provided for single point power connection.
 2. The control package shall include the following at a minimum:
 - a. 24 VAC transformer
 - b. Disconnect switch
 3. The control package shall include the following options:
 - a. Fan Status Relay
 4. Control Interface – Unit shall be factory run tested and end devices shall be factory wired to terminal strip in an external junction box and tested for wiring continuity.

2.3 SPLIT SYSTEM CONDENSING UNIT (Alt Bid)

- A. Material & Connections: Copper tubing with brass-to-brass threaded connections for TXVs.
- B. Suction Lines: 3/4" ODF (models 18-36) or 7/8" ODF (models 42-60).
- C. Coil Design: Multi-position (upflow, downflow, horizontal) with factory-installed TXV bulbs.
- D. Safety Features: Mandatory refrigerant detection sensors to trigger blower activation/shutdown during leaks.
- E. Installation: Requires specific tools for A2L, including dedicated leak detectors and specialized gauges.
- F. Compatibility: Designed for use with R-32 (GWP 675) and R-454B (GWP 466).
- G. Heavy-gauge galvanized steel casing with weather-resistant powder-coat finish.
- H. Scroll compressor with internal temperature and pressure protection.
- I. Factory refrigerant charge for condenser and 10 ft. of line set.
- J. Louvered coil guards on all sides.
- K. Refrigerant controls: Compressor contactor, condenser fan, high/low pressure switches, liquid line drier (field-installed).
- L. Cooling operation down to 55°F standard; down to 0°F with head-pressure control accessory.

2.4 FAN COILS

- A. Manufacturers:
 - 1. Base Bid: Trane – Basis of Design
 - 2. Alternate Bid:
 - a. Johnson Controls, Inc.
 - b. Carrier
- B. Manufacturer must clearly define any exceptions made to Plans and Specifications. Any deviations in layout or arrangement shall be submitted to engineer prior to bid date for approval. Mechanical Contractor is responsible for expenses that occur due to exceptions made.
- C. Cabinet Construction
 - 1. (Horizontal/Vertical) Concealed Unit: Construction shall be a minimum 18-gauge galvanized steel. The unit shall be acoustically and thermally insulated.
- D. Accessories
 - 1. Filters: 1-inch plenum air filters shall be provided and installed on all units.
 - 2. Disconnect Switch: Unit shall be acoustically and thermally insulated.

E. Cabinet Insulation

1. Closed cell insulation shall be the only acceptable material for insulating in accordance with ASHRAE 62-89R. Matted or fiber-glass insulation of any type is not acceptable.
2. Insulation shall meet UL rating 94-5v for fire hazard classification which satisfied flame and smoke safety requirements.

F. Fan Assembly

1. Fans: Centrifugal forward-curved double-width, double-inlet corrosion resistant wheels, statically and dynamically balanced, direct driven. Fans shall be constructed of metal with metal housing for long-term high reliability and shall be in the blow through configuration.
2. Motors: All motors are brushless DC (BLDC)/electronically commutated motors (ECM) factory-programmed and run-tested in assembled units. The motor controller is mounted in a touch-safe control box with a built-in integrated user interface and LED tachometer. If adjustments are needed, motor parameters can be adjusted through momentary contact switches accessible without factory service personnel on the motor control board.
 - a. Motors will soft-ramp between speeds to lessen the acoustics due to sudden speed changes. Motors can be operated at three speeds or with a field-supplied variable speed controller. The motor will choose the highest speed if there are simultaneous/conflicting speed requests.
 - b. All motors have integral thermal overload protection with a maximum ambient operating temperature of 104°F and are permanently lubricated. Motors are capable of starting at 50 percent of rated voltage and operating at 90 percent of rated voltage on all speed settings. Motors can operate up to 10 percent over voltage.

G. Coils

1. Hydronic coil(s) shall be factory-installed and consist of aluminum plated fins and seamless copper tubes. Coils shall be constructed with 144 aluminum-plated fins per foot (.305 m). The 3/8 inch OD tubes shall be mechanically expanded into the fin collars. Coils shall be burst tested at 450 psi (air) and leak tested at 100 psi (air under water). Coil connections shall be 5/8 inch OD copper tubing.

H. Drain Pan

1. Drain Pan(s) shall be constructed of corrosion resistant material. Acceptable materials include polymer or stainless steel.
 - a. Drain pan shall be sloped in two planes, pitched toward drain connection to ensure complete condensate drainage when unit is installed level. Drain pan shall be insulated with closed-cell insulation. Spray foam insulation inside the drain pan is not acceptable.
 - b. Drain pan shall be easily removable for cleaning and for inspections per ASHRAE 62-89R, without disconnecting piping, wiring or unit removal. Contractor shall be responsible for any unit modifications to ensure easy removal for cleaning and inspection, without cost to the owner.

I. Controls

1. Terminal interface shall be provided for use with field-supplied, low-voltage thermostat or a third-party controller.
2. The control box shall contain a relay board which includes a line voltage to 24-volt transformer, quiet contactors (for electric heat units), and an optional disconnect switch. All

- end devices shall be wired to a low-voltage terminal block and run-tested, only a power connection and/or thermostat connection is needed to commission the unit.
3. When normally open valves are selected, inverting relays shall be provided for use with standard thermostats.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in conformance with ARI 435.
- C. Install assembled unit on 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. Roof Ventilators
- C. Ceiling Exhaust Fans
- D. Make-Up Air Unit
- E. Kitchen Hood Exhaust Fan

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 ROOFTOP CENTRIFUGAL EXHAUSTERS

- A. Manufacturers:
 - 1. Base Bid – Greenheck

- 2. Alternate Bid
 - a. Penn Ventilator
 - b. Cook

- B. Furnish and install rooftop centrifugal exhausters. Unit shall be direct drive or belt-drive as indicated. Housing shall be heavy gauge spun aluminum in custom color selected by the Architect, weatherproof, with integral shield. Fan wheel shall be of centrifugal design, statically and dynamically balanced. Fan shall have integral factory-formed base. Housing shall have wiring channel. Unit shall be of direct discharge design. Motor and fan assembly shall be mounted on vibration isolators. Unit shall be equipped with bird screen, backdraft damper, and safety disconnect switch.
- C. Fan shall be mounted on Roof Curb furnished and installed by this Contractor.

2.2 ROOF VENTILATORS

- A. Manufacturers:
 - 1. Base Bid – Greenheck
 - 2. Alternate Bid
 - a. Cook
 - b. Penn Ventilator
- B. Roof ventilators shall be of the size shown on the drawing. Vent housing shall be heavy gauge aluminum in custom color selected by the Architect with hoods designed for intake or exhaust. All vertical seams shall be continuously welded with lock formed seams on hood ends. Hoods shall be stressed and sloped for drainage. Provide aluminum expanded metal bird screen with 85% free area.
- C. Provide an insulated fabricated UniBeam roof curb, and backdraft damper on exhaust ventilators only.
- D. Roof caps shall be Penn Model 11FR or approved equal. Mount roof cap on roof curb.

2.3 EXHAUST FANS (INLINE AND CEILING)

- A. Manufacturers:
 - 1. Base Bid Greenheck
 - 2. Alternate Bid
 - a. Penn Ventilator Zephyr
 - b. Cook
 - c. Acme
- B. Furnish and install ceiling/inline exhaust fans. Units shall be direct drive models. Fans shall have acoustically insulated housing and shall have maximum sound level ratings as noted. Air deliveries shall be as indicated in the schedule and all fans shall bear the AMCA Certified Ratings Seal for air capacities only and the UL label. Manufacturer shall submit vibration amplitudes and magnetic motor hum levels in decibels. Units shall be equipped with integral backdraft dampers which shall be chatterproof. Fans shall have true centrifugal wheels with inlet perpendicular to or remote

from inlet grille. Ceiling model grilles shall be aerodynamic design of eggcrate shape in custom color selected by the Architect and provide 85% free open area. Terminal box shall be provided with cord, plug, and receptacle inside the housing, entire fan, motor, and wheel assembly shall be removable without disturbing the housing. Motors shall be suitably grounded and mounted on rubber-in-shear vibration isolators.

- C. Furnish Lek-Trol variable speed controller.

2.4 KITCHEN HOOD EXHAUST FAN

- A. Manufacturers
 - 1. Base Bid Greenheck CUBE Model
 - 2. Alternate Bid:
 - a. Penn Ventilator
 - b. Cook
 - c. ACME
 - d. Captiveaire
- B. Roof exhaust blowers shall be of the belt drive, upblast, vertical discharge type. Housing shall consist of heavy gauge aluminum construction. All spun parts shall have a rolled bead for added rigidity and shall be specially spun so as to seal the pores of the aluminum providing greater resistance against oxidation and deterioration.
- C. The fan wheel shall be all aluminum of the centrifugal blower type featuring backward inclined blades and a tapered inlet shroud. Wheels shall be statically and dynamically balanced.
- D. Inlet cone shall be aluminum and of the centrifugal blower type. Motor and drives shall be enclosed in a weather-tight compartment, separate from the exhaust airstream. Air for cooling the motor shall be supplied to the motor compartment by way of an air tube from an area free of contaminated exhaust fumes. Motors shall be of the heavy duty, permanently lubricated, sealed ball bearing type. Drives shall be sized for 165% of motor horsepower capabilities and of the cast iron type, keyed to the fan and motor shafts. Variable pitch drives shall be standard. Fan shaft shall be of steel construction, turned, ground, and polished to precise tolerances in relationship to the hub and bearings. Drive belts shall be of the oil-resistant, non-static, non-sparking type with life expectancy of over 24,000 hours. Bearings shall be flanged and of the permanently lubricated, permanently sealed, ball bearing type capable of over 200,000 hours bearing life. The entire drive assembly and wheel shall be removable, as a complete unit, from the support structure without disassembling the external fan housing. The complete drive assembly shall be mounted on rubber vibration isolation. Furnish with unit factory wired and mounted NEMA-3R disconnect switch.
- E. For all belt drive units requiring Type A construction, all interior and exterior parts, including wheel, wheel hub, supporting posts, fan shaft, drive assembly, and all outside fasteners shall be of aluminum or non-ferrous construction. Type A construction shall include a five-year warranty. Fans shall be licensed to bear the AMCA ratings seal for air and sound performance.
- F. Furnish and install with grease drip trap on fan and hinged base.

- G. Fan shall be mounted on Roof Curb furnished and installed by this Contractor. Fan shall bear a UL-762 listing for restaurant grease applications and include a heat baffle below the motor.
- H. Paint in color selected by the Architect.

2.5 MAKE-UP AIR UNIT

- A. Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
 - 1. Base Bid Greenheck Fan Corporation
 - 2. Alternate Bid
 - a. Captiveaire
- B. Manufactured Units: Unit with Integral Heating and Cooling shall be fully assembled at the factory and consist of an insulated metal cabinet, an outdoor air intake weather hood with aluminum mesh, condensate drain pan, chilled water coil, hot water coil, sensors, curb assembly, motorized intake damper, supply air blower assembly, electrical control center with factory mounted disconnect. All specified components and internal accessories factory installed and tested and prepared for single point high voltage connection.
- C. Cabinet:
 - 1. Materials: Formed, double-wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - a. Outside casing: 18-ga, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Pre-painted components as supplied by the factory shall have polyester urethane paint in custom color selected by the Architect on 18-ga G60 galvanized steel. Base rail is 12-ga, galvanized (G90) steel. Components that receive a painted finish per A/E specification shall be painted with a polyester urethane powder coat.
 - b. Internal assemblies: 24-ga, galvanized (G90) steel except for motor supports which shall be a minimum 14-ga galvanized (G90) steel.
 - 2. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL-181.
 - a. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - 1) Thickness: 1" (25 mm)
 - 2) Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - 3) Location and application: Floor of each unit shall be insulated with fiberglass insulation. Full interior coverage from "Heating on".
 - 3. Access Panels: Unit shall be equipped with insulated hinged access panels to provide easy access to all major components. Access panels shall be fabricated of 18-gauge galvanized G90 steel.
 - 4. Supply Air Blower Assembly Options: Forward curve blower: Blower assembly consists of an electric motor and a belt driven, double width, and double inlet forward curve blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on minimum 1.125" thick neoprene vibration isolators.

5. Control Center/Connections:
 - a. Unit 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.
 6. 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 double pitched in opposite directions to provide positive draining. Drain connector shall be sealed at penetration through cabinet wall.
 7. 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.
 8. Packaged DX: Unit shall be equipped with a Packaged DX System to include compressor(s), evaporator and condenser coil(s), condenser fans and all appurtenant controls as specified elsewhere in this section. The packaged DX System is to be an integral module, incorporated into the unit. Stand-alone packaged DX Systems that are connected to the unit, or systems that require hardware or equipment that is not integral to the unit are not acceptable.
 9. Motorized Inlet Air Damper: to be of low leakage type and shall be factory installed.
 10. Sensors are considered to be a part of various optional operational modes or device controllers and are to be factory supplied and installed as specified by the A/E.
 11. Curb Assembly: A curb assembly shall be made of galvanized steel provided by the factory for field assembly and installation as part of this division. The curb shall include a duct adapter(s) for supply air. The installing 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.
 12. Frost Control for optional water coil.
- D. Blower FC:
1. Blower section construction, Supply Air: Belt drive motor and blower shall be assembled onto a minimum 14-ga galvanized steel platform and must have neoprene vibration isolation devices, minimum of 1-1/8" thick.
 2. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
 3. Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.
 4. Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.
 5. Blower 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 3/4 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPA's 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. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be supplied with an adjustable drive pulley. Comply with requirements in Division 23 05 13, matched with fan load.

2. Motors shall be 60-cycle, 3-phase, 460-volt.

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 remote panel, thermostats and sensors or it can be operated as a heating system controlled by a Building Management System (BMS).
2. Variable Frequency Drive (VFD): Unit shall have factory installed variable frequency drive for modulation of the supply air blower assembly. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
3. Sensors to be provided with the unit:
 - a. Heating Inlet Air Sensor
 - b. Cooling Inlet Air Sensor
 - c. Dirty Filter Sensor

G. Gas Heating

1. Unit shall include a natural gas furnace.
2. Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Gas furnace shall consist stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
4. Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
5. Unit shall include a single gas connection and have gas supply piping entrances in the unit base of through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.
6. Options:
 - a. High Turndown Modulating Natural Gas Furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment. Gas heater shall be capable of capacity turndown ratio as shown on the unit rating sheet. Heat trace shall be included on the condensate drain line.

H. Filters:

1. Unit shall have 2" thick MERV 13 disposable pleated filters following the outdoor air intake in a V-bank arrangement and shall be accessible from the exterior of the unit.

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 exhauster 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. Duct Cleaning
- D. Air Turning Devices/Extractors
- E. Backdraft Dampers
- F. Combination Fire and Smoke Dampers
- G. Duct Access Doors
- H. Fire Dampers
- I. Flexible Duct Connections
- J. Volume Control Dampers
- K. Diffusers
- L. Registers/Grilles

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

1.4 QUALITY ASSURANCE

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

1.5 REGULATORY REQUIREMENTS

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

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

- A. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having G60 zinc coating of in conformance with ASTM A90.
- B. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061- T6 or of equivalent strength.
- C. 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 Underwriters Laboratories under their UL-181 standards as Class 1 air duct and comply with NFPA Standard No. 90A.

2.2 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Construct T's, bends, and elbows with radius of not less than 12 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. 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 Duct 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

2.3 AIR TURNING DEVICES/EXTRACTORS

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

2.4 BACKDRAFT DAMPERS.

- A. Gravity Backdraft Dampers, Size 18 x 18" (450 x 450 mm) or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturers standard construction.
- B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: 16 gage 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.

2.5 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- B. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum 1" (25 mm) thick insulation with sheet metal cover.
 - 1. Less Than 12" Square: Secure with sash locks.
 - 2. Up to 18" Square: Provide two hinges and two sash locks.
 - 3. Up to 24x48": Three hinges and two compression latches with outside and inside handles.
 - 4. Larger Sizes: Provide an additional hinge.
- C. Access doors with sheet metal screw fasteners are not acceptable.

2.6 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.
- B. 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.

2.7 FIRE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- 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 Model IBDZ.
- D. Fusible Links: UL 33, separate at 160°F with adjustable link straps for combination fire/balancing dampers.

2.8 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.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.

2. Net Fabric Width: Approximately 2" (50 mm) wide.
3. Metal: 3"wide, 24-ga (0.6 mm thick) galvanized steel.

2.9 VOLUME CONTROL DAMPERS

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

2.10 LOUVERS

- A. Manufacturers:
 1. Construction Specialties Model 4157.
 2. Other acceptable manufacturers offering equivalent products.
 - a. 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.
- D. Mounting: Furnish with interior screw holes in jambs for installation.
- E. Shall be furnished in custom color selected by the Architect.

2.11 RECTANGULAR CEILING DIFFUSERS

- A. Manufacturers:
 1. Krueger Model 5SH
 2. Tuttle & Bailey Model RC
 3. Titus TDV
 4. Price SMX/AMS

- B. Type: Square and rectangular, multi-louvered diffuser to discharge air in pattern as indicated on drawings.
- C. Frame: Surface mount type or lay-in grid type.
- D. Fabrication: Steel or aluminum with baked enamel custom color selected by the Architect.
- E. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.12 CEILING AND WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Manufacturers:
 - 1. Krueger Model 580
 - 2. Acceptable equal by Anemostat, Titus, Carnes, Metalaire, Tuttle & Bailey, Price provided specifications are met.
- B. Type: Streamlined blades, 3/4" minimum depth, 3/4" maximum spacing, with blades set at 35° horizontal face 22-ga steel.
- C. Frame: 1-1/4" margin with countersunk screw mounting.
- D. Fabrication: Steel filter grille with hinged face and custom color to be selected by the Architect.

2.13 SUPPLY REGISTERS

- A. Manufacturers:
 - 1. Krueger Model 5880
 - 2. Approved equal: Anemostat, Titus, Carnes Metalair, Tuttle & Bailey, Price
- B. Type: Streamlined and individually adjustable blades, 3/4" minimum depth, 3/4" maximum spacing with spring or other device to set blades, vertical face, double deflection.
- C. Frame: 1-1/4" margin with concealed mounting and gasket.
- D. Fabrication: Aluminum extrusions, with factory enamel finish in custom color to be selected by the Architect.
- E. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.
- F. Curved Supply Register (SR) shall be Titus Model S300FL or equal, double deflection, curved supply register, long blade front with damper/extractor.

2.14 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Manufacturer
 - 1. Krueger Model 580

2. Acceptable equal by Anemostat, Titus, Carnes, Metalaire, Tuttle & Bailey, Price.
- B. Type: Streamlined 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 factory enamel finish in custom color to be selected by the Architect.
 1. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.15 HEAVY DUTY RETURN AND EXHAUST GRILLE

- A. Manufacturer
 1. Krueger Model 5480
 2. Acceptable equal by Anemostat, Titus, Carnes, Metalaire, Tuttle & Bailey, Price
- B. The heavy-duty return grille shall be a Krueger model S480. This grille must have 38° deflection (H and V models) on 1/2" centers or 0° deflection (HV and VZ models) on 3/8" centers made of 14 gage steel. The blades must be held in place by mullions placed behind the grille and welded to the frame. The frame of the grille must be constructed of a minimum of 16 gage steel with countersunk screw holes. This frame must also produce a border of 1 1/4" around all sides of the grille with mitered corners.
- C. Damper shall be made of heavy gage steel and operable from the face of the return grille.
- D. PERFORMANCE The manufacturer shall provide published (printed or electronic) performance data for the diffuser. Performance data shall include 2 - 7 octave band sound power levels. The diffuser shall be tested in accordance to the data standards at the time of product introduction or ANSI/ASHRAE Standard 70.
- E. FINISH The paint finish shall be in a custom color selected by the Architect and be an anodic acrylic paint, baked at 315°F for 30 minutes. The paint thickness shall be 0.8 – 1.0 mils, gloss at 60° per ASTM D523-89 of 50 – 85%, pencil hardness per ASTM D3363-92A of HB – H, crosshatch adhesion per ASTM D3359-83 of 4B – 5B, impact per ASTM D2794-93 of direct impact >100 in/lb and reverse impact >80 in/lb, salt spray per ASTM B117-9048 of 96 hours, humidity per ASTM D2247-92 of >500 hours and water soak per ASTM D870-92 of 250 hours.
- F. FILTER: Grille shall come with 1" filter frame and filter.

2.16 ROUND DUCT MOUNTED DIFFUSERS

- A. Manufacturers:
 1. Krueger, Model SDMGDR
 2. Approved equal: Anemostat, Titus, Carnes Metalair, Tuttle & Bailey, Price

- B. Grille shall have individually adjustable blades on 3/4" centers with friction pivots made of (.030" - .035") thick extruded aluminum, plastic blade pivots are not acceptable.
- C. The frame of the grille must be constructed of (.050" - .062") thick extruded aluminum with countersunk screw holes. The grille frame shall have a gasket to minimize air leakage due to perturbations in the duct. The end caps on the grille shall be curved to match the duct diameter. Standard flat grilles attached to saddle taps will not be acceptable.
- D. The unit shall employ a mechanically locked felt gasket to seal the connection between the barrel and frame along the length of the unit to reduce leakage. All frame joints are to be mechanically fastened.
- E. Finish in custom color selected by the Architect.

2.17 COMBINATION FIRE SMOKE DAMPERS

- A. Model: FSD35 Series Combination Fire Smoke Dampers.
- B. Ratings:
 - 1. Fire Resistance: 1-1/2 hours in accordance with UL555.
 - 2. Smoke Rating: FSD36 – Leakage Class II Smoke Damper in accordance with UL555S.
 - 3. Air Flow Rating: 2000 FPM.
 - 4. Differential Pressure Rating: 4in. wg.
- C. Construction
 - 1. Frame: 5 inches x minimum 16 ga roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 ga U-channel type frame.
 - 2. Blades:
 - a. Style: Single skin with 3 longitudinal grooves
 - b. Action: Opposed
 - c. Material: Minimum 16 ga galvanized steel
 - d. Width: Maximum 6 inches
 - 3. Seals:
 - a. Blade: Inflatable silicone fiberglass material to maintain smoke leakage rating to a minimum of 450°F. Mechanically attached to blade edge (glue-on) or grip type seals are not acceptable.
 - b. Jamb: Stainless steel, flexible compression type.
 - c. Linkage: Concealed in frame
- D. Axles: Minimum ½" diameter plated steel, hex-shaped, mechanically attached to blade.
- E. Mounting: Vertical and/or Horizontal
- F. Release Temperature: 165°F
- G. Actuator:
 - 1. Type: Electric 24V, 60 Hz, two-position, fail close.
 - 2. Mounting: External

3. Finish: Mill galvanized

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. Install in accordance with manufacturer's instructions.
- D. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- E. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- G. Use double nuts and lock washers on threaded rod supports.
- H. Connect terminal units to supply ducts with 1' maximum length of flexible duct. Do not use flexible duct to change direction.
- I. Connect diffusers to low pressure ducts with 8' maximum length of flexible duct held in place with strap or clamp. (Concealed areas only.)
- J. Connect flexible ducts to metal ducts with adhesive.
- K. Set plenum doors 6 to 12" above floor. Arrange door swings so that fan static pressure holds door in closed position.
- L. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- M. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- N. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- O. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ductwork in accordance with NFPA 96. Provide minimum 8x8" size for hand access, 18x18" size for shoulder access, and as indicated. Provide 4x4" for balancing dampers only. Review locations prior to fabrication.

- P. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings, and hinges.
- Q. Demonstrate re-setting of fire dampers to Owner's representative.
- R. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- S. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- T. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- U. Support duct silencers independent of ductwork.
- V. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- W. Install diffusers to ductwork with airtight connection.
- X. Paint ductwork visible behind air outlets and inlets matte black.

3.2 CLEANING (NEW DUCTWORK)

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

3.3 SHEET METAL WORK

- A. Provide air duct systems as shown on the drawings. Construction methods, unless otherwise specified, shall conform with the recommendations in the latest edition of the ASHRAE Guide. Unless otherwise noted, ductwork shall be galvanized steel.
- B. All ductwork seams and joints shall be caulked with white silicone caulking and taped before caulking compound cures. In lieu of caulk and tape, ductwork may be sealed with Benjamin Foster #30-02 duct seal or Cadoprene #725 installed per manufacturer's instructions. (Except for exposed spiral duct in Cafeteria, Café Lobby.)
- 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 Architects 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 12 times the width of the duct.
- G. All work shall be designed and fabricated to keep resistance losses to a minimum. Use gradual transformation and long radius elbows. Where sharp turns are necessary, the elbow or plenum shall be fabricated with vanes concentric with the inside and outside radii.
- H. Where indicated and where required for proper system air balancing, furnish and install opposed blade adjustable volume dampers as hereinafter specified.
- I. Volume dampers are to be key operated opposed blade type and are to be operable from the bottom.

3.4 HANGERS

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

3.5 DUCT ACCESS DOORS AND FIRE DAMPERS

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

END OF SECTION 230890

SECTION 230900 - ATC SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Control Equipment & Wiring
- B. Software Including Graphics Package
- C. Sequence of Operation

1.2 REFERENCES

- A. American National Standards Institute (ANSI)
- B. ANSI/ISA 5.5-1985 Graphic Symbols for Process Displays
- C. ANSI/IEEE 260.1 2004, Standard Letter Symbols for SI and Certain Other Units of Measurements (SI Units, Customary Inch Pound Units and Certain Other Units)
- D. ANSI/ASHRAE 135-2016, BACnet® - A Data Communication Protocol for Building Automation and Control Networks

1.3 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

- A. Acronyms used in BAS.
 - 1. BAS – Building Automation System
 - 2. EMCS – Energy Management and Control System
 - 3. GUI – Graphical User Interface
 - 4. HVAC - Heating, Ventilation, Air Conditioning
 - 5. I/O - Input/output
 - 6. ISA - Industry Standard Architecture
 - 7. O&M - Operation and Maintenance
 - 8. Niagara4 – Software framework for building device-to-enterprise applications and Internet-enabled products.

1.4 STANDARDS COMPLIANCE

- A. All equipment and material to be from manufacturer's regular production, UL and/or ULC or CSA certified, manufactured to standard quoted plus additional specified requirements.
- B. Where UL and/or ULC or CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
- C. Additional applicable codes and standards:

1. National Electrical Code -- NFPA 70.
2. Local Electrical Codes
3. Federal Communications Commission -- Part J.

1.5 SCOPE OF WORK

- A. Modification and extension of the existing Niagara system to serve all new and existing HVAC equipment.
- B. SOLANCO HIGH SCHOOL: Provide ATC Control for all new equipment and existing equipment including:
 1. Packaged Rooftop Air Handling Units
 2. Boiler
 3. Hot Water Pumps
 4. Exhaust Fans
 5. Cabinet Unit Heaters, Unit Heaters and Connectors
 6. VAV Boxes
 7. Mini-Split Units
 8. Energy Recovery Units
- C. Actuators, sensors, end switches, flow switches, relays, and other control devices shall be replaced throughout. Wiring can be reused if it is compatible with the new system requirements.
- D. Provide ATC Control for all equipment. Match all sequences as noted.
- E. Provide thermostats, temperature sensors, temperature / humidity, sensors, temperature / humidity / CO2 sensors, actuators, control valves and other sensors necessary to maintain environmental comfort throughout the building. Provide actuators for all dampers provided by others and for dampers provided by ATC.
- F. Contractor shall run all new IP wiring to all controllers and devices as required. Owner will provide two interface locations in the project. Final locations to be determined.
- G. Provide full graphics package as part of software. Customize the graphics to match the HVAC system and sequences. Note that graphics software and controls cannot be proprietary, locked, or non-accessible to the owner or his service agencies. The owner shall be given full and complete access as well as be provided with the unlimited permission to permit any outside control service company to access, service, and modify any and all system programming.
- H. 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.
- I. System shall be a Tridium Niagara System installed by Certified Niagara Technicians and configured with open NICS statements to ensure open architecture to all other Tridium Workstations.

- J. System shall be 100% BACnet IP protocol.
- K. System must be capable of full integration with existing campus server (Niagara N4).
- L. Provide Niagara N4 based Network Manager, DDC Controllers, Building Controllers, Network Management Tools, Programming Tools, Web Browser based Graphical User Interface, sensors, relays, campers, actuators, and other equipment as may be necessary to provide a complete system.
- M. Programmable controllers shall be Distech and shall be compatible with existing District Niagara System. Proprietary or licensed controllers are not permitted.
- N. Programming software, software tools and programming tools shall be licensed to the district so that they can allow anyone to use them. Customer shall be able to download all software upgrades for free.
- O. Designated District personnel shall be trained on use of software. Forty (40) hours of training shall be included in the bid.
- P. Tridium hardware shall be open and serviceable by any trained and certified Tridium service professional. Full access shall be provided to the Owner and his service agencies.
- Q. All labor, material, equipment, and services not specifically referred to in this specification that are required to fulfill the functional intent of this specification shall be provided at no additional cost to the Owner.
- R. The work covered by this specification and related sections consists of providing submittals, labor, materials, engineering, technical supervision, and transportation as required to furnish and install a fully operational BAS to monitor and control the facilities listed herein, and as required to provide the operation specified in strict accordance with these documents, and subject to the terms and conditions of the contract. The work in general consists of but is not limited to, the following:
 - 1. Furnish and install all to achieve system operation, any control devices, conduit and wiring, programming, hardware, software, etc. in the facility as required to provide the operations as specified.
 - 2. Furnish complete operating and maintenance manuals and field training of operators, programmers, and maintenance personnel.
 - 3. Perform acceptance tests and commissioning of the new control system.

1.6 BIDDER QUALIFICATIONS

- A. The Automatic Control System shall be provided and installed complete by competent, trained mechanics regularly employed by the Factory authorized representative of the automatic control equipment. Control manufacturer shall have an established office within a 50-mile radius of the project and that office shall be 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.

1.7 BAS OPEN SYSTEM DESIGN AND QUALIFICATIONS

- A. Open System Design: It is the expressed goal to implement an open Building Automation System that will allow products from different manufacturers and/or suppliers to be integrated into a single unified system in order to provide flexibility for expansion, maintenance, and service of the system. The BAS manufacturer/contractor must provide proof of open system design as outlined below.
- B. The controls system shall utilize the Niagara4 software framework.
 - 1. The Contractor shall have a minimum of 5 years' experience in the sales, installation, engineering, programming servicing and commissioning of Niagara4.
 - 2. Submit the Niagara Compatibility Statement (NiCS) via a letter from the manufacturer. The NiCS shall have no connectivity restrictions and all aspects of the Niagara Framework will be provided to maintain an Open System Design. The System as provided shall confirm with the following NiCS properties (Station Compatibility In, Station Compatibility Out, Tool Compatibility In, AND Tool Compatibility Out shall each have a value of "All").
 - 3. The controls system shall conform to the following guidelines for communication protocols.
- C. BACnet shall be used for all BAS provided controllers.
 - a. The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the BACnet International and all controllers used shall be BACnet Listed with documentation on the BACnet website (<https://www.bacnetinternational.net/btl/search.php>)
 - b. The use of BACnet Communications protocol alone shall NOT warrant an "Open System Design." Manufacturers must adhere to all aspects of "BAS Open System Design and Qualifications" and "Acceptable System Manufacturers" sections to comply.
 - c. Modbus shall only be acceptable for third party devices.
 - 2. LonTalk shall only be acceptable for sites with existing LonTalk controls architecture where the owner has explicitly stated that the LonTalk architecture must remain in place.
 - 3. Fox protocol shall NOT be acceptable.
 - 4. Proprietary communications protocols will NOT be acceptable.
 - 5. A software programming tool shall be provided for this project and adhere to the following guidelines:
- D. All software tools needed for full functional use, including programming of controllers, Niagara4 Framework network management and expansion, and graphical user interface use and development, of the BAS described within these specifications shall be provided to the owner or his designated agent.
 - 1. The software programming tool shall be free of charge and openly available for download from the internet.
 - 2. For any manufacturer that does not have a free programming tool the manufacturer must provide the tool with this project for a minimum of 5 years with proof of availability via letter from the manufacturer.
 - 3. Any licensing required by the manufacturer now and to the completion of the warranty period, including changes to the licensee of the software tools and the addition of

hardware corresponding to the licenses, to allow for a complete and operational system for both normal day to day operation and servicing shall be provided.

1.8 PRODUCTS NOT FURNISHED UNDER THIS SECTION

- A. Central personal computers and printers located at District Office and Building Maintenance Office will be provided by the School District

1.9 SYSTEM DESCRIPTION

- A. Description – This specification for a Building Automation System (BAS) as detailed herein shall be strictly enforced. Provide a Building Automation System (BAS) incorporating BACnet Testing Laboratories (BTL) certified BACnet devices communicating over a BACnet IP network at the field (building) level and at the network level. All controllers will connect to the owner's Local and/or Wide Area Network, as designated by the owner, and shall communicate seamlessly with the owners Niagara 4 Server. The BAS shall consist of Direct Digital Control (DDC) controllers, Building Controllers (BC), network management tools, programming tools, web browser based Graphical User Interface, sensors, relays, valves, actuators, and other equipment as may be necessary to provide for a complete and operational control system for the HVAC and other building related systems as described within these specifications.
 - 1. The system installed shall seamlessly connect devices other than HVAC throughout the building regardless of subsystem type, i.e., HVAC, lighting, and power systems devices should easily coexist on the same network channel without the need for gateways. BACnet components not supplied by the primary manufacturer of the BAS shall be integrated to share common software for network communications, time scheduling, alarm handling, and history logging.
 - 2. The documentation contained in this section and other contract documents pertaining to HVAC Controls is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions shown or as implied in the contract documents.
 - 3. System configuration and monitoring shall be performed via a PC-type computer. Under no circumstances shall the PC be used as a control device for the network. It can be used for storage of data.
 - 4. Provide remote access via WEB Brower and mobile applications for unlimited users without requiring proprietary software fees, seat licensing or restricted/annual licensing.

1.10 SUBMITTALS

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

1.11 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.

1.12 WARRANTY

- A. Provide all services, materials, and equipment necessary for the successful operation of the entire BAS System for a period of 2 year after final acceptance by the Owner.
- B. The adjustment, required testing, and repair of the system includes all computer equipment and all sensors and control devices.
- C. The on-line support services shall allow the local BAS subcontractor to dial out over telephone lines to monitor and control the facility's building automation system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends, and holidays.
- D. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the BAS manufacturer shall dispatch the appropriate personnel to the job site to resolve the problem within 4 hours of the time that the problem is reported.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.

- B. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.
- C. Approved Control Companies:
 - 1. DYNATECH Controls, Inc.
 - a. Contact Mark Myers 717-393-5930, mark@dynatechcontrols.com

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate BACnet communication protocols in one open interoperable system.
- B. All components and controllers supplied under this Division shall be true “peer-to-peer” communicating devices. Components or controllers requiring “polling” by a host to pass data shall not be acceptable.
- C. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
- D. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network. Systems employing a “flat” single tiered architecture shall not be acceptable.
 - 1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 - 2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.3 ACCEPTABLE SYSTEM MANUFACTURERS AND CONTRACTORS

- A. Provide a building automation system supplied by a company regularly engaged in the manufacturing and distribution of building automation systems for a minimum of 5 years.
- B. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll-free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.
- C. BACnet/IP communication protocol must be used for all BAS manufacturer provided controllers (including terminal devices such as VAVs, FCUs, etc.)
- D. Any approved manufacturer that can supply both equipment and controls must provide controls pricing separately from equipment pricing.

- E. Acceptable Manufacturers
 - 1. Distech Controls (Basis of Design)
 - 2. All other manufacturers/contactors besides the “Basis of Design” manufacturer (including those listed above) must submit a compliance matrix outlining “C – Comply”, “D – Does Not Comply”, and “E – Exclude” for the entirety of the 230900 and 230993 sections prior to bid award.
- F. Being listed as an approved manufacturer/contractor does not preclude the bidder from meeting all aspects and requirements of this specification.
 - 1. Those bidders not prequalified prior to review of bids will not be considered responsive. To be prequalified a bidder must be accepted to bid the project by the engineer either by a bid addendum or documented RFI response from the engineer. No other prequalifications shall be acceptable.

2.4 QUALITY ASSURANCE

- A. All new building automation system products on this project shall be provided by a firm that is a registered ISO 9001:201508 manufacturer, for a minimum duration of 5 years, at time of bid.

2.5 COMPUTER HARDWARE

- A. Provide the following computer hardware for this project:
 - 1. Computers will be provided by the Owner.
 - 2. Uninterruptible Power Supplies.
 - a. Provide the OWS, Server, and each network/building controller with individual UPS to provide clean, reliable, noise-filtered power at all times and to protect and maintain systems operation throughout short-term power interruptions of up to 15 minutes duration. Acceptable Manufacturer is APC.

2.6 REMOTE ACCESS AND CYBER SECURITY BEST PRACTICES

- A. Remote Access
 - 1. The BAS contractor shall comply with owner IT infrastructure security policies for remote access. The owner IT team shall provide VPN, firewalls, etc. as needed for secure remote access.
 - 2. A VPN and firewall must be used for secure remote access.
 - 3. Cyber Security Best Practices
- B. Unless predetermined by the owner IT team the BAS network shall be separate from the owners IT infrastructure besides a single point connection for remote access (owner provided internet access). All ethernet switches and communication backbone required for a fully operational BAS shall be provided by the BAS contractor.
 - 1. Refer to “Communication Backbone” section of this specification for further details on segmenting the network (VLANs, subnets) and when managed switches (with port security, network user interface, etc.) are required based on building size / type.
 - 2. Do not use factory provided usernames and passwords. Update passwords and usernames regularly for strong system security.

3. Update software and firmware regularly.
4. Adhere to controls manufacturer hardening guidelines where applicable.

2.7 OPERATOR SOFTWARE

A. Real-Time Displays

1. Provide a visual graphical representation of buildings, floor layouts, each piece of mechanical equipment and/or mechanical system that duplicates the represented system, presented as a web page via any industry standard web browser, where applicable.
2. Graphics shall include at a minimum the value of each input, each output, each setpoint, alarms and graphical representation of trend logs.
3. On-Line Help: Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system.

B. Security:

1. Each operator shall be required to log on to that system with a username and password in order to view, edit, add, or delete data.
2. System security shall be selectable for each operator.
3. The system administrator shall have the ability to set passwords and security levels for all other operators.
4. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object.
5. Each operator shall automatically be logged off the system if no keyboard or mouse activity is detected.
6. This auto log-off time shall be set per operator password.
7. All system security data shall be stored in an encrypted format.
8. System Diagnostics:

C. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers.

1. The failure of any device shall annunciate to the operator.
2. Third-Party Windows-Based Programs:

D. The system shall be capable of utilizing third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages.

1. Graphics generation shall be done using standard Windows packages.
2. No proprietary graphics generation software shall be needed.
3. Overrides:

E. It shall be possible for the operator to override automatic analog and digital output commands.

1. Where the BAS software normally originates these outputs, the provision shall exist for the operator to terminate automatic BAS control of any particular output and to originate a manual analog or digital output command.
2. The provision shall exist for the operator to return analog or digital output command functions to automatic BAS software control.

3. Password Protection: Provide security system that prevents unauthorized use unless operator is logged on.
- F. Trend Data:
1. System shall periodically gather historically recorded selected samples of object data stored in the field equipment (global controllers, field controllers) and archive the information on the operator's workstation (server) hard disk.
 - a. Archived files shall be appended with new sample data, allowing samples to be accumulated over 3 years.
 - b. Systems that write over archived data shall not be allowed unless limited file size is specified.
 - c. Samples may be viewed at the operator's terminal in a trend log.
 - d. Logged data shall be stored in spreadsheet format.
 - e. Operator shall be able to scroll through all trend log data.
 - f. Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to six object types at the same time in different colors and these Graphs shall show object type value relative to time.
 2. Operator shall be able to change trend log setup information such as time intervals and objects logged
 3. Graphics:
- G. The operator's workstation shall display all data associated with the project.
- a. Operator's workstation shall display all data using 3-D graphic representations of all mechanical equipment.
 - b. System shall be capable of displaying graphic file, text, and dynamic object data together on each display.
 2. Information shall be labelled with descriptors and shall be shown with the appropriate engineering units.
 - a. All information on any display shall be dynamically updated without any action by the user.
 - b. Terminal shall allow user to change all field-resident BAS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display.
 - c. Animated graphic objects shall be displayed as a sequence of multiple bitmaps to simulate motion.
 3. Analog objects may also be assigned to an area of a system graphic, where the color of the defined area would change based on the analog objects value.
 - a. For example, an area of a floor-plan graphic served by a single control zone would change colour with respect to the temperature of the zone or its deviation from setpoint.
 - b. Separate Displays shall be supplied, specific to the project, to form the following overall presentation style.
 4. All Displays will be linked in a logical fashion using hyperlink style (single left mouse click on text/display object/dynamic to load linked display if programmed)
 5. Entire system shall operate without dependency on the operator's terminal. Provide graphic generation software at each workstation.
 6. Alarms:

- H. Operator's terminal shall provide audible, visual, electronic, and printed means of alarm indication.
 - 1. Any alarm may be handled based on its individual or assigned class actions.
 - a. Displayed on the Alarm console.
 - 1) The system shall be provided with a dedicated alarm window or console.
 - 2) This window will notify the operator of an alarm condition and allow the operator to view details of the alarm and acknowledge the alarm.
 - 3) Alarm reports shall be viewable via the BAS system and available for delivery by electronic mail (e-mail) or printing.
 - 2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal.
 - a. Each entry shall include a description of the event-initiating object generating the alarm, time and date of alarm occurrence, time, and date of object state return to normal, and time and date of alarm acknowledgement.
- I. Scheduling:
 - 1. Operator's terminal display of weekly schedules shall show all information in easy-to-read 7-day (weekly) format for each schedule.
 - 2. Exception schedules (non-normal schedules, such as holidays or special events) shall display all dates that are an exception to the weekly schedules.
 - 3. At the operator's terminal, the system user shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.
 - 4. Archiving:
- J. Store back-up copies of all controller databases in at least one OWS and the server.
 - 1. Provide continuous supervision of integrity of all controller databases.
 - 2. Data base back up and downloading to occur over LAN without operator intervention.
 - 3. Operator to be able to manually download entire controller database or parts thereof.
 - 4. Reports:
- K. Provide a report facility to generate and format for display, printing, or permanent storage, as selected by the operator, the reports as specified in this section.
 - 1. Provide the software to automatically generate any report specified; the user will be able to specify the type of report, start time and date, interval between reports (hourly, daily, weekly, monthly) and output device.
 - 2. As a minimum, the following reports shall be configured on the system:
 - a. Dynamic Reports: To allow operator to request a display of the dynamic value for the user specified points which shall indicate the status at the time the request was entered and updated at an operator modifiable scan frequency.
 - b. Summary Report: To permit the display or printing of the dynamic values for the user specified points.
 - c. Trend Reports: To permit the trending of points selected by the operator, including as a minimum digital input and output, analog input, and output, set points, and calculated values.
 - d. Historical Data Collection: Provision shall be made to ensure historical data is not lost.

- e. Alarm Summary: Provide a summary of all points in alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceeded, and time and date of occurrence.
- f. Disable Point Summary: Provide a summary of all points in the disabled state and include as a minimum point acronym and point description.
- g. Run Time Summary: Provide a summary of the accumulated running time of selected pieces of equipment with point acronym and description, run time to date, alarm limit setting. The run time shall continue to accumulate until reset individually by means of suitable operator selection.
- h. Schedule Summary: Provide a summary of all schedules and indicate as a minimum, which days are holidays and, for each section, the day of the week, the schedule times, and associated values; for digital schedules value will be on or off; for analog schedules value will be an analog value.
- i. User Record Summary: Provide a summary of all user records to include as a minimum; username, password, initials, command access level and point groups assigned.

2.8 BAS CONTROLLERS

A. All controllers on the job shall have the following minimum requirements:

1. IP Communication (BACnet/IP)
 - a. BACnet/IP communication protocol shall be used for all BAS manufacturer provided controllers (including terminal devices such as VAVs, HP's, FCUs, etc.)
 - b. Support for IPv4 addressing
 - c. DHCP support and Auto DNS
 - d. Baud rate of not less than 100 Mbps
 - e. 2 - RJ45 ports each capable of supporting 10/100 Base-T.
 - 1) Supporting controller daisy chaining on the Ethernet network via integral switch functionality.
 - 2) Integrated fail-safe should allow for communication when the controller is powered down.
 - 3) All controllers shall be able to communicate peer-to-peer without the need for a Network Control Unit (such as JACE, NAE, etc.) and shall be capable of assuming all responsibilities typically assumed by a Network Control Unit.
 - f. Any controller on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.
 - 1) The resulting network will be a 'Flat' topology with all devices (controllers, workstations, ...) connecting at the same physical network level
2. Memory and Processing
 - a. 512KB of RAM and 4GB of non-volatile flash memory.
 - b. 32-bit microprocessor operating at a minimum of 600 MHz
 - c. Each individual controller shall have an embedded web based HTML5 visual interface with the following functionality without reliance on any other controller for access:
3. Typical and custom control processes
 - a. Scheduling

- b. Energy management applications
 - c. Alarm management applications
 - d. Historical/trend data for points specified
 - e. Maintenance support applications
 - f. Graphical interface
 - g. Shall be capable of monitoring/controlling the following types of inputs/outputs:
- 4. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - a. Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
 - b. Digital outputs including Form C relay outputs and Triac outputs
 - c. Analog outputs of 4-20 mA and 0-10 Vdc.
 - d. A minimum of 10% spare capacity for each point type for future point connection.
 - e. Any software required for programming shall be unlicensed and openly available
- 5. Auto commissioning features shall be available for VAVs, HPs and FCUs to schedule automatic testing and record values (air flows, pressures, temperatures, etc.) for different operating modes. The auto commissioning feature shall be able to email reports and run commissioning on a specified schedule.
- 6. Power and Environmental Requirements:
 - a. 24-VAC with local transformer power
 - b. The controllers shall also function normally under ambient conditions of -40 °F [-40 °C] to 158 °F [-70 °C] and 0% to 90% RH (non-condensing).
 - c. Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
 - d. Code Compliance:
- 7. "FIPS 140-2 Level 1 Compliant" cryptographic module
 - a. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
 - b. UL916 Energy management equipment
 - c. FCC Rules part 15, subpart B, class B
 - d. UL94-V0 flammability rating

2.9 CONTROL PANELS

- A. Indoor control cabinets located in offices or dry/dust free environments shall be fully enclosed NEMA 1 Type construction with hinged door, and removable sub-panels or electrical sub-assemblies.
- B. All outdoor control cabinets and control cabinets located in mechanical/electrical rooms shall be NEMA 4.
- C. Control panels containing more than 4 controllers shall be provided with a terminal strip for field wiring. All control wiring inside the panel shall be between a terminal strip and controller inputs/outputs. All field control wiring shall be terminated at the terminal strip. Field control wiring inputs/outputs shall never be run directly to inputs/outputs of controller.

2.10 Auxiliary Control Devices, Sensors, and Transmitters

- A. All devices to be supplied and installed by the ATC Contractor.

B. Damper Actuators:

1. Features:

- a. Electronic Damper Actuators: Actuators shall be sized for torque required for sealing the damper at load conditions, shall utilize v-bolt dual nut clamp with v-shaped tooth cradle coupling, and shall be capable of being mechanically or electrically paralleled to increase torque if required. Electronic overload protection or digital rotation-sensing circuitry shall be used to prevent any damage to the actuator during a stall condition (and shall not require the use of end switches for protection). Fail-safe operation shall be provided as mechanical spring return (or electrical if spring return is not available for actuator size).
 - b. Terminal Unit Actuators: Actuators shall be sized for torque required for sealing the damper at load conditions and shall utilize V-bolt dual nut clamp with a V-shaped toothed cradle or an ISO-style direct-coupled mounting pad coupling. Close of differential pressure rating of 200psi.
 - c. Operating Temperature: -22° F to 122° F (-30° C to 50° C)
2. Protection / Rating: Minimum requirement NEMA type 2 / IP54 mounted in any orientation, NEMA 4X for outdoor applications, and UL94-5V(B) flammability for terminal unit actuators
3. Input/Output:
- a. Two Position: Digital output including Form C relay output
 - b. Modulating: 4-20 mA and 0-10 Vdc.
 - c. End Switches / Auxiliary Switches (if applicable): SPDT, digital inputs from dry contact closure
 - d. Power:
4. Match existing power.
- a. Electronic Damper Actuators: Two position spring return shall be 24 or 120VAC as required by manufacturer and proportional actuators shall be 10VA at 24VAC or 8W at 24VDC
 - b. Terminal Unit Actuators: maximum of 1 VA at 24VAC or 1 W at 24VDC
 - c. Agency Approvals:
5. Electronic Damper Actuators: ISO 9001, UL, UL(C) and CSA C22.2 No. 24-93.
- a. Terminal Unit Actuators: CE, UL 60730-1A/-2-14, CAN/CSA E60730-1, CSA C22.2 No. 24-93, CE according to 89/336/EEC.
 - b. Approved Manufacturers / Models:
6. Distech Controls
- a. Belimo

C. Air Flow Measuring Station:

1. Install new airflow measuring stations on the supply and exhaust side of all Energy Recovery Units.
2. Features:
 - a. Duct Air Flow Measuring Station: Highly accurate thermal dispersion airflow and temperature measuring probe(s) designed for duct sizes 8 – 120". Multiple velocity and temperature points on one or more probes installed in the duct or plenum are averaged to arrive at air measurements. Capable of displaying the flow and temperature at each sensing point. Moisture resistant flex sensors protected from the elements with a thin conformal coating. Includes airfoil-Shaped aluminum

- probes with LCD screen digital display controller and the correct number of ancillary probes based on the size of the duct.
- b. Fan Inlet Air Flow Measuring Station: Shall be capable of monitoring and reporting the airflow and temperature at each fan inlet location scheduled through two or four sensing circuits and a control transmitter that communicates with the building automation system (BAS). Includes aerodynamically shaped, surface mount fan inlet sensors and LCD screen control transmitter.
 - c. Operating Temperature: -20° F to 120° F (-29° C to 49° C)
 3. Protection / Rating: U.L. 94 flame rated, high impact ABS
 4. Input/Output:
 - a. Velocity Output: 4-20mA or 2-10 VDC with 500-ohm resistor
 - b. Temperature Output : 4-20mA or 2-10 VDC with 500-ohm resistor
 - c. BACnet MS/TP (for duct air flow measurement stations)
 - d. Power: 24-VAC (± 15%); 15 VA
 5. Accuracy: ±3% of reading with ±0.25% repeatability and ±0.10° F (0.06° C)
 6. Range: 0-5000 FPM for ducts and 0-10,000 FPM for fan-inlet
 7. Agency Approvals: All components are U.L. Listed and compliant with RoHS directive 2002/95/EC, AMCA, and ISO 9001. In addition, duct airflow measuring stations are compliant with Part 15 of the FCC rules and BTL.
 8. Approved Manufacturer / Model: Ebtron
 9. Water Pressure Sensor:
- D. Features: Provide water pressure sensors as indicated within the sequences of operations and/or controls diagrams with operating range suitable for application. Select range such that it covers from zero pressure to twice the amount of pressure desired for control purposes or that could be encountered. Sensor shall include over pressure input protection of a minimum two times rated input, burst pressure of a minimum five times rated input, and 17-4PH stainless steel wetted parts
1. Operating Temperature: -40° F to 185° F (-40° C to 85° C)
 2. Protection / Rating: 17-4 PH Stainless Steel or NEMA 4X if enclosure provided
 3. Input/Output: 4-20 mA output proportional to water pressure
 4. Power: 3-wire circuit for power and output (COM, OUT, EXC) with EXC being 15-30 VDC (18-30 VAC)
 5. Accuracy: ± 1% of full scale
 6. Range: selectable pressure range 1 – 10,000 psi
 7. Agency Approvals: CE & RoHS Compliant
 8. Approved Manufacturer / Model:
 - a. Setra (Model 2091)
 - b. Distech Controls (PS-2LSP Series)
- E. Water Differential Pressure Sensor:
1. Features: Provide water differential or gage pressure sensors as indicated within the sequences of operations and/or controls diagrams suitable for application. Select range such that it covers from zero differential pressure up to a differential static pressure of 20% to 50% in excess of the maximum static pressure that could be encountered. Remember that if the sensor is used for the control of a chilled water bypass and is located across, for example, a chilled water AHU coil, the pressure drop of both the coil and the associated valve at full design flow have to be taken into account. Sensor shall include

over pressure input protection of a minimum two times rated input, burst pressure of a minimum five times rated input, and 17-4PH stainless steel wetted parts.

2. Operating Temperature: -4° F to 185° F (-20° C to 85° C)
3. Protection / Rating: NEMA 4 or NEMA4X if enclosure provided
4. Input/Output: 4-20 mA output proportional to pressure sensed
5. Power: 3-wire circuit for power and output (COM, OUT, EXC) with EXC being 15-30 VDC (18-30 VAC)
6. Accuracy: ± 1% of full scale
7. Range: selectable pressure range 1 – 500 psi
8. Agency Approvals: CE & RoHS Compliant
9. Approved Manufacturer / Model:
 - a. Setra (Model 231)
 - b. Distech Controls (PS-2LDP Series)

F. Air Pressure Sensor – Duct / Space / Air Differential (Filter/Coil Monitoring):

1. Features: Provide air pressure sensors as indicated within the sequences of operations and/or controls diagrams suitable for application. Select range as detailed below based on application type. Sensor shall include over pressure input protection of a minimum two times rated input or 20 psi (whichever is greater).
 - a. Duct Mounted Static Pressure Sensor: Select range such that it covers from zero duct static pressure relative to the exterior of the duct up to a static pressure of between 20% and 50% in excess of the maximum static pressure that could be encountered in the duct relative to the duct exterior. Typically, for low pressure commercial duct consider using a range of 0 to 2" wc. (0 to 500Pa), for medium pressure duct use a range of 0 to 6" wc. (0 to 1500Pa) and for high-pressure duct use a range of 0 to 10" wc (0 to 2500 Pa).
 - b. Space Static Pressure Sensor: Input range of -0.2" to + 0.2" wc (-50 to +50 Pa).
 - c. Air Differential Pressure Sensor: Select range as required, taking into consideration pressure drop across filter or coil. Typically, 0-2" wc (0 to 500 Pa) range for low-pressure commercial duct.
 - d. Operating Temperature: 32° F to 140° F (0° C to 60° C)
2. Protection / Rating: Polycarbonate (UL 94 V-0 Approved)
3. Input/Output: 4-20 mA, 0-5V, or 0-10V output proportional to pressure sensed
4. Power: 24VAC or 24VDC
5. Accuracy: ± 1% of full scale
6. Range: selectable pressure range 0- 20" w.c.
7. Agency Approvals: UL listed
8. Approved Manufacturer / Model:
 - a. Setra
 - b. Distech Controls

G. Air Pressure Switch:

1. Features: Provide air pressure switches as indicated within the sequences of operations and/or controls diagrams suitable for application. Select range as required, taking into consideration pressure drop across filter or coil. Typically, 0.2-2" wc (0 to 500pa) range for low-pressure commercial duct. Sensor shall include over pressure input protection of a minimum two times rated input or 20 psi (whichever is greater).
2. Operating Temperature: -4° F to 140° F (-20° C to 60° C)

3. Protection / Rating: IP54 (NEMA 13) polycarbonate
4. Input/Output: SPDT switch digital input from dry contact closure
5. Power: N/A
6. Accuracy: $\pm 1\%$ of full scale
7. Range: selectable pressure range 0- 12" w.c.
8. Agency Approvals: N/A
9. Approved Manufacturer / Model:
 - a. Setra
 - b. Distech Controls

H. Carbon Dioxide (CO₂) Sensor:

1. Features: Provide a space or duct carbon dioxide gas detection sensor as indicated within the sequences of operations and/or control diagrams. Optional features include BACnet communication, LCD display, setpoint adjustment, or integral temperature/humidity sensors (optional features shall be provided, if necessary, based on project scope).
2. Operating Temperature: 32° F to 122° F (0° C to 50° C)
3. Input/Output: 4-20 mA, 0-10 or 0-5 Vdc output compatible with BMS proportional to carbon dioxide concentration
4. Power: 24VAC or 24VDC
5. Accuracy: $\pm 3\%$ of full scale
6. Range: 0 to 2000 ppm
7. Duct / Immersion / Outdoor Temperature Sensors:

I. Features: Provide Thermistor or RTD temperature sensors as indicated within the sequences of operations and/or control diagrams. Install sensor as detailed below.

- a. Outside Air Temperature Sensor: Provide outside air temperature sensors with Aluminum LB with PVC sun and windscreen weatherproof enclosure with conduit entrance. Install in an area where exhaust or roof heat will not affect readings.
- b. Duct Mounted Temperature Sensor (ducts less than 10ft² [1m²] in cross-sectional area): Provide duct mounted, single point probe temperature sensor with 0.25" [6.35 mm] stainless steel probe of length between one-third and two-thirds of the duct width.
- c. Duct Mounted Averaging Temperature Sensor (ducts greater than 10ft² [1m²] in cross-sectional area): Provide duct mounted, averaging, temperature sensor with probe length of 12 feet [3.66m] minimum or 1ft per ft² (3.25m per m²) of duct cross-sectional area, whichever is greater. Copper sheathed or plenum rated flexible construction.
- d. Liquid Temperature Sensor: Provide immersion thermowell mounted temperature sensors for liquid temperature sensing. Rigid 0.25" [6.35mm] stainless steel probe of length, which is, at minimum, 20% of the pipe width. Provide Brass or Stainless steel thermowell (316 or 304) with thermal grease to aid temperature sensing.
- e. Strap-on Temperature Sensor: Provide strap-on mounted temperature sensors where thermo well mounted sensors cannot be mounted.
- f. Operating Temperature: -58° F to 212° F (-50° C to 100° C) dependent upon application
2. Input/Output: thermistor or RTD compatible with BAS
3. Power: dependent upon sensor type – provide as per manufacturers recommendations
4. Accuracy: $\pm 1.0^{\circ}\text{F}$ (0.5 °C)

5. Range: -58° F to 212° F (-50° C to 100° C) dependent upon application
 6. Duct / Outdoor Humidity Sensors:
- J. Features: Provide duct / outdoor humidity sensors as indicated within the sequences of operations and/or control diagrams. Outside air humidity sensors shall have ABS hinged weatherproof housing with conduit entrance and shall be installed in an area where exhaust or roof heat will not affect readings. Duct humidity sensors shall have ABS housing with conduit entrance. In addition, all humidity sensors shall have 9" probe length, 60-micron HDPE filter, reverse voltage protection, and be output limited.
1. Operating Temperature: 32° F to 122° F (0° C to 50° C)
 2. Input/Output: 4-20 mA two wires, 0-10 Vdc and/or 0-5 Vdc output proportional to relative humidity range of 0% to 100%
 3. Power: 24VAC or 24VDC
 4. Accuracy: ± 3% of full scale
 5. Range: 5-95%RH
 6. Space Temperature Sensors:
- K. Features: Provide space temperature sensors as indicated within the sequences of operations and/or control diagrams. Shall consist of an element within a ventilated cover. Space sensors located in mechanical rooms and large public spaces shall contain a network jack but shall have no ability to adjust temperature setpoint (Set Point Adjustment). Space sensors located in other spaces shall include options (setpoint adjustment, network jack, fan speed selection, override switch, and/or digital display) in accordance with the drawings and sequences of operations.
1. Operating Temperature: 32° F to 122° F (0° C to 50° C)
 2. Input/Output: dependent upon sensor type, provide as per manufacturers recommendations
 3. Power: dependent upon sensor type – provide as per manufacturers recommendations
 4. Accuracy: ± 1.0°F (0.5 °C)
 5. Range: 32° F to 122° F (0° C to 50° C)
 6. Space Humidity Sensors:
- L. Features: Provide space humidity sensors as indicated within the sequences of operations and/or control diagrams. Sensor shall have reverse voltage protection and be output limited.
1. Operating Temperature: 32° F to 122° F (0° C to 50° C)
 2. Input/Output: dependent upon sensor type – provide as per manufacturers recommendations
 3. Power: dependent upon sensor type – provide as per manufacturers recommendations
 4. Accuracy: ± 3% of full scale
 5. Range: 5-95%RH
 6. Combination Relative Humidity and Temperature Sensors: Where there is a requirement for the monitoring of both relative humidity and temperature at the same location, the BMS Contractor shall provide a combination relative humidity sensor and temperature sensor. The individual sensors must each meet the specifications details above.
- M. Low Limit Thermostats:
1. Features: Provide low limit thermostats as indicated within the sequences of operations and/or control diagrams. Safety low limit thermostats shall be vapor pressure type with

an element 20' [6.1 m] minimum length. Element shall respond to the lowest temperature sensed by any 1' section. Low limit shall be manual reset only.

2. Operating Temperature: -60° F to 160° F (-51° C to 71° C)
3. Input/Output: 2 SPDT switches, digital inputs from dry contact closure
4. Power: N/A
5. Accuracy: $\pm 1.0^{\circ}\text{F}$ (0.5°C)
6. Range: adjustable range 34° F to 70° F (1°C to 21°C)
7. Current Relay/Switch:

- N. Features: Provide current sensing relays as indicated within the sequences of operations and/or control diagrams. The current sensing relay shall be rated for the applicable load shall have input and output isolation via current transformer, and the output relay shall have an accessible trip adjustment over its complete operating range. Whenever the status of a single speed motor is monitored it shall be done via a current sensing relay. The BAS contractor shall provide current sensing relays at the MCC starters (or at the local starter for motors without a MCC starter).

1. Operating Temperature: 5° F to 140° F (-15°C to 60°C)
2. Input/Output: digital input from dry contact closure
3. Power: Current relay shall be self-powered with no insertion loss
4. Accuracy: $\pm 2\%$ of full scale
5. Current Sensor:

- O. Features: Provide current sensors as indicated within the sequences of operations and/or control diagrams. The current sensors shall be rated for the applicable load and shall be reverse polarity protected and output limited.

1. Operating Temperature: -20° F to 120° F (-29°C to 49°C)
2. Input/Output: 4-20 mA, 0-10 or 0-5 Vdc output proportional to current draw
3. Power: Current sensor shall be self-powered with no insertion loss
4. Accuracy: $\pm 1\%$ of full scale
5. Damper End Switch:

- P. Features: Provide damper end switches as indicated within the sequences of operations and/or control diagrams. End switches shall prove a damper has reached the position specified. End switches shall be integral to damper actuator unless otherwise specified.

1. Input/Output: SPDT switch, digital input from dry contact closure

2.11 COMMUNICATION BACKBONE

- A. To allow for future expandability, cyber security measures, optimal bandwidth, and enhanced data trending this project shall adhere to the below communication backbone requirements.

- B. Fiber Optic Network:

1. Required for all project exceeding 5 levels (including rooftops/cellars), 100m between ethernet connections, 250 controllers, or more than 1 type of operational technology residing on the same network (CCTV, lighting, access, etc.).
2. Network edge switches provided for each floor with provisions for expansion capability.
3. Fiber optic cable shall be run between network switches.
4. 1 Centralized Network Controller with Aggregation Switch shall be provided for the building:

- a. Must be a managed fiber / ethernet network with the following network features:
 - 1) Packet switching and loop detection
 - 2) Port security with MAC address lockdown and the ability to close all open ports including port connected to a daisy-chain of IP devices.
 - 3) Segregation / isolation with VLAN configuration capabilities. The system shall allow system-wide auto-creation of a VLAN simply by specifying one or more ports to be on that VLAN, and automatically ensure that traffic passes between the selected ports. There must not be any restriction on port location.
 - 4) Web browser based graphical user interface for information logging (network overloads, bandwidth consumption, port status, connection status, and trending)
 - 5) Support both Ethernet and Power over Ethernet (PoE)
 - 6) Support fiber optic backbone(s) with Single-strand, Single-mode Optical Fiber OS1/OS2 9/125 μm , up to 12.5 miles [20.1 km] reach
 - 7) BACnet protocol specific network traffic support and support for all other communication protocols
 - 8) Expansion capability of up to 256 Edge Switches
 - 5. Edge Switches:
 - a. Shall provide 1 per floor
 - b. Must be compatible with Centralized Network Controller with Aggregation Switch and support the managed network features described above
 - c. Support both Ethernet, Power over Ethernet (PoE), and Spanning Tree Protocol
 - d. Support all communication protocols
 - e. Minimum of 8 RJ45 ethernet ports (all controllers on floor must be connected to Edge switch directly or via daisy-chain IP topology)
 - f. Security Provisions: Individual VLAN provided per every 2 levels
- C. IP (CAT 5 / RJ45) Network
 - 1. BACnet/IP communication protocol shall be used for all BAS manufacturer provided controllers (including terminal devices such as VAVs, HPs, FCUs, etc.)
 - 2. For all buildings NOT exceeding 5 levels (including rooftops/cellars), 100m between ethernet connections, 250 controllers, or more than 1 type of operational technology residing on the same network (CCTV, lighting, access, etc.):
 - a. Ethernet Switches shall be provided as needed to support a fully functional BAS – fiber network shall not be required.
 - b. BACnet/IP communication for all BAS manufacturer provided controllers
 - c. Modbus TCP shall only be used for third party systems / equipment that do not support BACnet/IP
 - d. Modbus RTU and BACnet MS/TP only to be used for third party systems / equipment that do not support BACnet/IP provisions (VFDs, boilers, etc.)
- D. Modbus RTU and BACnet MS/TP (RS-485) Network: Only to be used for systems / equipment that do not have IP provisions (VFDs, boilers, etc.)

2.12 INSTALLATION OF SENSORS

- A. Install sensors according to manufacturer's recommendations.

- B. Mount sensors rigidly and adequately for operating environment.
- C. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 1' [9 m] of sensing element for each 1 ft² [1 m²] of coil area.
- D. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- E. Install outdoor air temperature sensors on north wall at designated location with sun shield.
- F. Install building pressure pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.
- G. High and low limit thermostats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

2.13 COORDINATION

- A. All work shall be performed at times acceptable to the Engineer/Construction Manager. Provide work schedule at the start of the job for the approval of the Engineer / Construction Manager. Schedule shall show when all staff and sub-contractors shall be on-site.

2.14 ELECTRICAL WORK, WIRING AND SAFETY

- A. Electrical work shall be in accordance ANSI/NFPA 70 and the local Electrical Code.
- B. Based on project location, Regional Regulation Compliance Certifications (CSA C22.1) will be required.
- C. Electrical wiring, terminal blocks and other high voltage contacts shall be fully enclosed or properly guarded and marked to prevent accidental injury to personnel.
- D. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 260000, and manufacturer's recommendations. Where the requirements of this Section differ from other Divisions, this Section shall take precedence.
 - 1. EMT conduit shall be used in mechanical/electrical rooms and exposed spaces.
 - 2. Rigid Galvanized Steel conduit shall be used outdoors.
 - 3. Plenum rated cable shall be used in concealed spaces/hung ceilings.
 - 4. All wiring associated with and required by the BAS shall be the responsibility of this contractor.
- E. The term "wiring" shall be construed to include furnishing of wire, conduit, and miscellaneous material and labor as required to install a total working system.

1. If departures from the contract documents are deemed necessary by the contractor, details of such departures, including changes in related portions of the project and the reasons, therefore, shall be submitted with the drawings to the Engineer for approval.
 2. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.
- F. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
- G. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
- H. Each run of communication wiring shall be a continuous length without splices when that length is commercially available.
- I. Label communication wiring to indicate origination and destination.
- J. Fiber optic cable shall comply with the following requirements:
1. Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125 μm .
 2. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

2.15 SUBMITTALS

- A. Schematic diagram of each controlled system. Label control points with point names.
- B. Bill of Material for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
- C. Specification sheets for each item including manufacturers descriptive literature, drawings, diagrams, performance and characteristic curves, manufacturer and model number, size, layout, dimensions, capacity, etc.
- D. Control schematics with narrative description and control descriptive logic fully showing and describing operation and/or manual procedures available to operating personnel to achieve proper operation of the building, including under complete failure of the BAS.
- E. Shop drawings for each input/output point showing all information associated with each particular point including sensing element type and location; details of associated field wiring schematics and schedules; point address; software and programming details associated with each point; and manufacturer's recommended installation instructions and procedures for each type of sensor and/or transmitter.
- F. Riser diagrams showing control network layout, communication protocol, and wire types.

- G. Network diagram of control, communication, and power wiring for BAS Server and OWS installation.

2.16 AS-BUILT DOCUMENTATION

- A. As-built documentation shall consist of 4 hard copies and one soft copy for all information described below
- B. The final documentation package shall include:
 - 1. As-built Submittals: Final as built control submittals and technical data sheets.
 - 2. Programming, Sequences, and Graphics: All programming, sequences, and graphics saved to an external hard drive.
 - 3. Operation and Maintenance Manuals: Factory operating and maintenance manuals with any customization required.
 - 4. Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as test procedures.

2.17 WARRANTY

- A. The BAS system labor and materials shall be warranted free from defects for a period of 2 Years after final commissioning and owner acceptance.

2.18 TRAINING

- A. BAS Contractor shall provide a minimum of 40 hours of training with course outline and materials for personnel designated by the owner.
- B. If desired manufacturer provided training on the use and operation of all products provided within these specifications shall be available for purchase and attendance by the Owner or his designated agent. A list of training courses with detailed course outline and duration with the associated cost shall be provided as part of the BAS submittals.

2.19 COMMISSIONING

- A. This Contractor shall provide full control system commissioning of the new system.
- B. Provide commissioning data sheets prior to acceptance testing.

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 26.

- 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 Owner's 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.
- F. All panels shall be installed in an accessible location as approved by the Owner. Panels above the ceiling will not be acceptable.

3.2 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.

3.3 ELECTRICAL WIRING SCOPE

- A. This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor. If power circuits are shown on the electrical drawings, this contractor shall continue the power run to the control device. If power circuits are not shown, this contractor shall coordinate with the electrical contractor to provide breakers at distribution panels for power to controls. This contractor is then responsible for power from the distribution panel.
 - 1. Coordinate panel locations. If enclosures for panels are shown on the electrical drawings, furnish the enclosures according to the electrician's installation schedule.
- B. This contractor shall not be responsible for power to control panels and control devices that are furnished by others unless it is part of the control interlock wiring.
- C. Refer to Coordination section for what devices this contractor is responsible to mount, and which are turned over to others to mount.
- D. This contractor shall be responsible for wiring of any control device that is furnished as part of this section of specification.

- E. Wiring for controls furnished by others: Provide control wiring for HVAC controls furnished by others. Wiring may include, but not limited to, interlocks, standalone thermostats, safeties, and remote-control devices such as valves, sensors, etc.
- F. Interlock wiring shall be run in separate conduits from BAS associated wiring.
- G. Provide network wiring for equipment that is called to be integrated to the BAS.

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. All low voltage control wiring shall be class 2. Control wiring that is not class 2 shall be run in separate conduits from Class 2 wiring. All wiring shall be plenum rated.
- B. Floor level network wiring between terminal units can be combined with thermostat and other low voltage wiring in the same conduit. All other network wiring shall be in dedicated conduits.
- C. Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes".
- D. Install building wire and cable according to Division 26 Section "Electrical Power Conductors and Cables".
- E. Installation shall meet the following requirements:
 - 1. Conceal cable and conduit, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway or conduit.
 - 3. Install concealed cable using plenum rated cable.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. All wiring in lab areas shall be in conduit.
 - 8. All unsupported risers shall be rigid steel conduit. Supported risers shall be EMT.
- F. Rigid conduit shall be steel, hot dip galvanized, threaded with couplings, ¾ inch minimum size, manufactured in accordance with ANSI C-80-1. Electrical metallic tubing (EMT) with compression fittings or intermediate metallic conduit (IMC) may be used as conduit or raceway where permitted by the NEC.
- G. Concealed control conduit and wiring shall be provided in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install in parallel banks with all changes in directions made at 90° angles.
- H. Install conduit adjacent to machine to allow service and maintenance.
- I. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

- J. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- K. Ground equipment.

3.5 COMMUNICATION WIRING

- A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling. All wiring shall be plenum rated.
- B. Do not install communication wiring in raceway and enclosures containing Class 1 wiring.
- C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- D. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
- E. Cable bundling:
 - 1. RS485 cabling run open air in accessible areas can be bundled with other class 2 low voltage cabling.
 - 2. RS485 cabling run between terminal units in conduits above ceilings or under floors or in inaccessible areas can be bundled with other Class 2 low voltage cabling.
 - 3. RS485 cabling run between floors shall be in a communication only conduit.
 - 4. RS485 conduit run long distances between utility rooms or between buildings shall be in a communication only conduit.
 - 5. Ethernet cabling shall be in a communication only conduit.
 - 6. Ethernet and RS485 can be run together.
 - 7. Fiber optics can be run with Ethernet and RS485 cabling as long as the conduit is bent to fiber optic standards and junction boxes are sized for fiber optic use.
- F. FLN Cabling:
 - 1. FLN cabling shall be low capacitance, 20-24-ga, twisted shielded pair.
 - 2. The shields shall be tied together at each device.
 - 3. The shield shall be grounded at one end only and capped at the other end.
- G. Ethernet Cabling:
 - 1. Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.
 - 2. CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.
 - 3. Solid wire shall be used for long runs, between mechanical rooms and between floors. Stranded cable can be used for patch cables and between panels in the same mechanical room up to 50' away.
 - 4. When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.
- H. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer's instructions.

- I. All runs of communication wiring shall be unspliced length when that length is commercially available.
- J. All communication wiring shall be labeled to indicate origination and destination data.
- K. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.6 IDENTIFICATION

- A. Match the existing wiring and conduit identification methods.

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
 - 3. Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
- B. Replace damaged or malfunctioning controls and equipment.
 - 1. Start, test, and adjust control systems.
 - 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 - 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.8 SYSTEM CHECKOUT AND STARTUP

- A. Inspect each termination in the MER control panels and devices to make sure all wires are connected according to the wiring diagrams and all termination are tight.
- B. After the controls devices and panels are installed and power is available to the controls, perform a static checkout of all the points, including the following:
 - 1. Inspect the setup and reading on each temperature sensor against a thermometer to verify its accuracy.
 - 2. Inspect the setup and reading on each humidity sensor against a hygrometer to verify its accuracy.
 - 3. Inspect the reading on each CO2 sensor using a calibration kit to verify the sensor range accuracy matches the DDC setup.
 - 4. Inspect the reading of each status switch to verify the DDC reads the open and close correctly.
 - 5. Command each relay to open and close to verify its operation.

6. Command each 2-position damper actuator to open and close to verify operation.
 7. Command each 2-position valve to open and close to verify operation.
 8. Ramp each modulating actuator to 0%, 25%, 50%, 75% and 100% to verify its operation.
 9. Ramp each modulating output signal, such as a VFD speed, to verify its operation.
 10. Test each safety device with a real-life simulation, for instance check freezestats with ice water, water detectors with water, etc.
- C. Document that each point was verified and operating correctly. Correct each failed point before proceeding to the dynamic startup.
 - D. Verify that each DDC controller communicates on its respective network correctly.
 - E. After all the points are verified, and power is available to the mechanical system, coordinate a startup of each system with the mechanical contractor. Include the following tests:
 1. Start systems from DDC.
 2. Verify that each setpoint can be met by the system.
 3. Change setpoints and verify system response.
 4. Change sensor readings to verify system response.
 5. Test safety shutdowns.
 6. Verify time delays.
 7. Verify mode changes.
 8. Adjust filter switches and current switches for proper reactions.
 9. Adjust proportional bands and integration times to stabilize control loops.
 - F. Perform all program changes and debugging of the system for a fully operational system.
 - G. Verify that all graphics at the operator workstations correspond to the systems as installed. Verify that the points on the screens appear and react properly. Verify that all adjustable setpoints and manual commands operate from the operator workstations.
 - H. After the sequence of operation is verified, setup the trends that are listed in the sequence of operations for logging and archiving for the commissioning procedure.

3.9 SYSTEM COMMISSIONING, DEMONSTRATION AND TURNOVER

- A. The BAS Contractor shall prepare and submit for approval a complete acceptance test procedure including submittal data relevant to point index, functions, sequence, inter-locks, and associated parameters, and other pertinent information for the operating system. Prior to acceptance of the BAS by the Owner and Engineer, the BAS contractor shall completely test the BAS using the approved test procedure.
- B. After the BAS contractor has completed the tests and certified the BAS is 100% complete, the Engineer shall be requested, in writing, to approve the satisfactory operation of the system, sub-systems and accessories. The BAS contractor shall submit Maintenance and Operating manuals at this time for approval. An acceptance test in the presence of the Engineer and Owner's representative shall be performed. The Owner will then shake down the system for a fixed period of time (30 days).

- C. The BAS contractor shall fix punch list items within 30 days of acceptance.
- D. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.

3.10 PROJECT RECORD DOCUMENTS

- A. Project Record Documents: Submit three (3) copies of record (as-built) documents upon completion of installation. Submittal shall consist of:
 - 1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11" x 17" prints.
 - 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements in the Control System Demonstration and Acceptance section of this specification.
 - 3. Operation and Maintenance (O & M) Manual.
 - a. Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - b. Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.
 - c. Graphic files, programs, and database on electronic media.
 - d. List of recommended spare parts with part numbers and suppliers.
 - e. Licenses, guarantees, and warranty documents for equipment and systems.
- B. Provide updated versions of Operating manuals.

3.11 COMMISSIONING

- A. A dedicated commissioning agent shall

PART 4 - CONTROL SEQUENCES

4.1 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 26.
- 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 8 hours dedicated instruction time.

4.2 CONTROL OF HOT WATER PUMPS AND HOT WATER SUPPLY TEMPERATURE

- A. The heating hot water pumps shall be controlled by a panel mounted lead/lag switch and as described elsewhere in this section and the pumps shall be energized through DDC System. The lead/lag sequence shall be as follows: The lead pump shall be energized and run continuously. A system differential pressure switch 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. The 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.

- B. Hot Water Reset Control shall be as follows:

<u>Outside Air Temperature</u>	<u>Hot Water Supply Temperature</u>
0°	180°F
70°F and above	140°F

- C. Starter for each pump shall be Hand/Off/Auto Type. When starter is in Auto Position, pump shall be controlled by DDC System.
- D. Provide the following to control variable speed pumping systems:
1. Differential pressure transmitters at the ends of the pipe runs (see Drawings)
 2. Receiver/Controller
 3. All interconnecting wiring and programming.
 4. Interface DDC System with pump system drives.
- E. Speed of pumps shall be varied as required to maintain minimum required pressure at end of system. Points shall be monitored and adjustable thru the computer.
- F. 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 VARIABLE SPEED HOT AND CHILLED WATER PUMPS

- A. Provide the following to control variable speed pumping system:
1. 2-way modulating ATC valve in pump bypass (sized by pump package manufacturer for min flow) wired to pump control system.
 2. Differential pressure transmitters at the ends of the pipe runs (12 per system)
 3. Receiver/Controller
 4. All interconnecting wiring and programming.
 5. Interface DDC System with pump system drives. DDC System shall control 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 thru the computer.

4.4 CONTROL OF BOILERS

- A. Boiler shall be controlled to maintain required supply water temperature. Temperature shall be adjustable thru the computer. ATC Damper for Combustion Air Louver shall be in open position whenever Boiler(s) or Water Heaters are firing.
- B. 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 boiler burners will be through DDC system. Energize two (min) boiler/burners below outside temperature of 30°F (adjustable).
- C. Provide gas/oil switchover through the DDC System.
- D. Blend pumps for each boiler shall run continuously when any boiler is enabled.

4.5 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.

4.6 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. System operator shall be capable of reading primary air CFM at each VAV box from central operator workstation through air monitoring device.
- D. 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 PACKAGED ROOFTOP AIR CONDITIONER UNIT (RTAC)

- A. This unit consists of a supply fan and exhaust fan with factory mounted variable speed drives, heat recovery section, direct expansion cooling coil and a hot water coil section.
- B. The ATC contractor shall provide DDC controllers and sensors for the units' control.
- C. The supply fan shall be started from a time schedule in the field installed DDC controller or from any of the intelligent wall unit sensor override pushbutton, located in the space. The Exhaust fan shall only operate if the supply fan is operating.
- D. When indexed to the unoccupied mode, the supply and exhaust fan is off, the outside air and

exhaust air dampers shall be closed. During the unoccupied modes the supply fan shall operate only to maintain the desired night setback temperature 65°F heating and setpoint temperature of 85° F cooling (adj) of all spaces served.

- E. When indexed to the occupied mode by the DDC system, the unit fan shall run continuously and the outdoor air damper shall be positioned to an adjustable minimum position as listed on the unit schedule. With outdoor air temperature below 55°F (adj.), the economizer dampers and Energy Recovery Wheel shall modulate to maintain 55° mixed air temperature. When the outdoor air temperature is above 55°F (adj.), the outdoor air damper shall be positioned to an adjustable minimum position, and the DX cooling will be stages to maintain discharge temperature setpoint. When the outdoor air temperature is below 55°F (adj.), and the unit is in heating mode, gas heat will be enabled to maintain the heating setpoint of 60°F (adj.) discharge air temperature.
- F. Dehumidification Mode: The units shall have modulating hot gas reheat that shall allow for independent control of the DX cooling coil leaving air temperature and the reheat coil leaving air temperatures. See Specification Section 230855 for detailed information
- G. Unit shall have Variable Frequency Drive control.
- H. Supply fan duct static pressure control: a remote duct static pressure sensor located 2/3rds the way down the supply duct, shall modulate the VFD to maintain duct static pressure setpoint.
- I. Exhaust Fan: A remote building static pressure sensor shall modulate the VFD to maintain the required space static pressure setpoint to provide building pressurization control.
- J. Safeties: A low limit thermostat (freezestat) shall de-energize the fan, close the outside air damper and fully open the heating control valve to the coil, if the coil discharge temperature drops below 40°F (adj.).
- K. An air flow switch shall be piped across the filters to provide a dirty filter status indication at the central operator's terminal.
- L. When the unit is indexed to the warm-up mode by the DDC system the supply fan shall start, the outdoor air damper will remain closed and the unit will be in recirculation mode and maintain a discharge temperature at 80°F (adj).
- M. Current switch serving the supply fan shall provide status inputs to the DDC system.
- N. Points List:
 - 1. Discharge Air Temperature (AI)
 - 2. Discharge Air Humidity (AI)
 - 3. Entering OA Temperature (AI)
 - 4. Leaving EA Temperature (AI)
 - 5. Supply Air Static Pressure (AI)
 - 6. Supply Fan VFD Speed (AI)
 - 7. Setpoint Adjustment – Discharge Air Temp (AO)
 - 8. Setpoint Adjustment – Discharge Air Humidity (AO)
 - 9. Hot Water Heating (AO)

10. DX Cooling – 2 Stage (1st Stage Modulating, 2nd Stage On-Off) (AO)
11. SA Fan VFD Speed (AO)
12. SA Fan Status (BI)
13. SA Fan Start/Stop (BO)
14. Alarms – DAT, Discharge Air Humidity, Smoke Detectors, SA Fan, Compressors, Freezestat
15. Local Building Static Pressure (AI)
16. Dirty Filters (BI)
17. OA Damper Position (AI)
18. CO2 Level
19. Hot Gas Reheat Coil (AO)

4.8 CONTROL OF EXHAUST FANS

- A. Control Type 2: These fans shall be controlled by means of tie-in with wall light switch. Provide time delay so that fan operates for 10 minutes (adjustable) after light switch is turned off.
- B. 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.
- C. Control Type 3 & 4: These fans shall be controlled as indicated on drawings.
- D. Control Type 5: These fans shall be controlled by means of wall mounted 2-speed switches.

4.9 CONTROL OF HOT WATER UNIT HEATERS

- A. 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 stand-alone and not connected to DDC System.

4.10 CONTROL OF HOT WATER CONVECTORS, CABINET HEATERS

- 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)

4.11 DOMESTIC THERMOSTATIC MIXING VALVE

- A. DDC System shall communicate through BACnet protocol with the TMV field controller.
- B. ATC shall map available field points to TMV controller.
- C. 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.

D. Points List:

1. Mixed water temperature at valve outlet
2. Valve position (if integrated with BAS)
3. TMV enable / status (if applicable)

E. Alarm:

1. High mixed water temperature (risk of scalding)
2. Valve failure or stuck position
3. Any deviation from setpoint outside allowable deadband

4.12 CONTROL OF DOMESTIC HOT WATER RECIRCULATING PUMP

A. ATC shall map available field points to CP controller.

B. 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 new DDC day-night system and shall be energized during the occupied cycle and de-energized during the unoccupied cycle.

C. Points List:

1. Pump status (ON/OFF)
2. Flow switch status (proving flow)
3. Return water temperature (loop temperature monitoring)
4. Pump runtime / hours (for maintenance)

D. Alarms:

1. Pump failure / not running when required
2. No flow detected / low flow
3. Abnormal return water temperature
Heating Coil Control Valve Position (AO)

E. A common thermostat shall control the VA box and WF radiation in those spaces that have WF radiation installed.

4.13 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.

B. Points List:

1. Cold water inlet temperature
2. Hot water outlet temperature
3. Storage tank temperature
4. Water heater ON/OFF status
5. Firing rate / modulation (if available)

6. Gas pressure (high/low) – for gas-fired units
7. Internal alarms/faults (ignition failure, sensor faults, low-water cutoff)

C. Alarms:

1. High tank temperature (>150–160°F)
2. Low hot water outlet temperature (failure to meet setpoint)
3. Ignition failure / water heater fault
4. Gas pressure high / low
5. Low water cutoff activation

4.14 POINTS LIST - BAS

- A. Refer to following points list. Refer to Section 23 0900-1.2K for additional points. These lists are for information only. Provide total number of points required to provide specified control sequence.

POINTS LIST

Air Handlers, Rooftop Air Units, Heat Recovery Units, Unit Ventilators, Fan Coils, Blower Coils (In addition to specifics in Equipment Specification)

ANALOG INPUT: Space Temperature
 Discharge Air Temperature
 Outside Air CFM

ANALOG OUTPUT: Setpoint Adjustment
 Damper Positions
 Valve Positions - Hot Water, Chilled Water (as applicable)

BINARY INPUT: Status
 Freeze
 Smoke (Units - over 2000 CFM)
 Air Flow (Air Handler Units Only - over 1000 CFM)

BINARY OUTPUT: Off-On

ALARMS: High Analog
 Low Analog
 Freeze
 Smoke (Units - over 2000 CFM):
 Condensate Overflow Shutdown/Alarm

PROGRAMS: Time Scheduling
 Start/Stop Opt.
 Trend

EXHAUST FANS (All Fans):

BINARY INPUT: Current
 Off-On
 Air Flow

PROGRAMS:	Time Schedule Start-Stop Opt.
 <u>HVAC PUMPS:</u>	
BINARY INPUT:	Status On-Off Flow Zone Pressures % Flow
BINARY OUTPUT:	On-Off Zone Pressure (Adjustment) % Flow (Adjustment)
ALARM:	Flow High Pressure Low Pressure Failure
PROGRAMS:	Trend
 <u>CHILLERS:</u>	
BINARY INPUT:	Status-On-Off
BINARY OUTPUT:	On-Off
ALARM :	General - Chiller
MISCELLANEOUS:	Chiller Plant Manager Interface
 <u>THERMAL STORAGE:</u>	
BINARY INPUT:	Temperature % Ice Build
ALARM :	Low Water High Ice General
PROGRAMS:	Time Schedule Trend
 <u>BOILERS:</u>	
BINARY INPUT:	Status-On-Off
BINARY OUTPUT:	On-Off
ALARM:	General
MISCELLANEOUS:	Burner Communication Interface (Full Interface Required)
 <u>WATER HEATERS/TANK:</u>	
BINARY INPUT:	Status-On-Off
BINARY OUTPUT:	On-Off
ALARM:	General
 <u>PUMPS (Plumbing System Pumps):</u>	
BINARY INPUT:	Status On-Off Flow
BINARY OUTPUT:	On-Off

ALARM: Flow

THERMOSTATIC MIXING VALVE:

BINARY INPUT: Status-On-Off

BINARY OUTPUT: On-Off

ALARM: General

4.15

END OF SECTION 230900

SECTION 230990 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

THIS SECTION IS FOR REFERENCE ONLY. CONTRACTOR SHALL COORDINATE BALANCING WITH OWNERS TESTING AND BALANCING CONTRACTOR, COMMISSIONING AGENT, AND THE ATC SUB-CONTRACTOR.

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 230010.
- B. Submit name of adjusting and balancing agency for approval within 10 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 set 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 QUALIFICATIONS

- A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with AABC or NEBB Certification.

1.5 SEQUENCING

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

1.6 T.A.B. REQUIREMENTS

- A. Note that all Hot Water and Chilled Water systems shall be fully rebalanced at the completion of the project. This includes water flows to both the new and existing equipment.
- B. Note that all air systems shall be fully rebalanced for any new piece of equipment. Existing air handling systems to remain do not need to be rebalanced.
- C. Note that outdoor air inlets for all Unit Ventilators are required to be measured and balanced.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 AGENCIES

- A. Eastern Air Balance
- B. Flood & Sterling
- C. TAB Works

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. Fan System: Adjust to within $\pm 5\%$ of design for exhaust system.
- 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 and/or the Project Commissioning Agent.

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, and 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

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| 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.

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|----|------|--|
| 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:

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|------|---------------------------------|
| 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 cable tray and conduits.
 - g. Revisions to electrical circuitry.
 - h. Actual equipment locations.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 - 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.

5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
 7. Provide one (1) hard copy and one (1) PDF electronic file on digital media acceptable to Architect/Engineer for Owner. Provide one (1) additional PDF electronic file for the Engineer.
- B. O&M Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Enable bookmarking of individual documents based upon file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel upon opening file.
 3. Provide two (2) copies of the PDF electronic files on digital media acceptable to Architect/Engineer. One copy shall be for the Owner and the other shall be for the Engineer.
- C. O&M Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.
1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2" x 11" paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders, if necessary, to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL", Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
 4. Supplementary Text: Prepared on 8-1/2" x 11" white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.

- b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.
- 6. Provide three (3) hard copies for Owner. Submit to Architect/Engineer for review and approval.

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

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. PPL Utilities: Brent Stauffer; (717) 837-6006; bestauffer@pplweb.com
- B. 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.
- C. The Owner will pay all utility company service costs.
- D. 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. Range Outlet: Verify location and mounting height with Architect before roughing-in.
 - 15. Water Cooler Outlet: Verify location and mounting height with Plumbing Contractor before roughing-in.
- B. Equipment shall be mounted as follows:
 - 1. Safety Switches: 5'-0" to top of enclosure.
 - 2. Enclosed Circuit Breakers: 5'-0" to top of enclosure.
 - 3. Enclosed Motor Controllers: 5'-0" to top of enclosure.
 - 4. Enclosed Contactors: 5'-0" to top of enclosure.
 - 5. Time Controls: 5'-0" to top of enclosure.
 - 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 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. 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.
- E. 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.
- F. Hood Lighting:
1. Provide switches, wiring and conduit as required for lighting fixtures provided with hood unless otherwise noted.
- G. 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.
- H. 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.
- I. 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.
- J. 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.
- K. 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.
- L. Premanufactured Display Case:
1. Provide installation and all interconnecting wiring for luminaires, switches and receptacles furnished with the display case.
- M. 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.
- N. Motorized Shade Motor:
1. Provide line voltage boxes/wiring and conduit as required by the manufacturer.
 2. Provide low voltage boxes/wiring and conduit as required by the manufacturer.
 3. Provide all control wiring in 3/4" conduit and install switches furnished with system.

1.7 DIVISION 21, 22, and 23 POWER REQUIREMENTS

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

1.8 COORDINATION OF RESPONSIBILITIES

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

		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.	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
8.	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
9.	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
10.	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
11.	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
12.	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
13.	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
14.	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
15.	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
16.	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
17.	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
18.	Lavatory Faucets		
	a. Furnish and install unit	X	
	b. GFI receptacle at unit		X
	c. Transformer(s)	X	
	d. Low voltage wiring to valves	X	

		DIV 23	DIV 26
19.	Paddle Fans		
	a. Furnish and install unit	X	
	b. Furnish Switch (Speed Controls)	X	
	c. Install Switch (Speed Controls)		X
	d. Provide power wiring thru switch (Speed Controls)		X

		DIV 23	DIV 26
20.	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. Motorized Projection Screens
 - 8. Kitchen Equipment
 - 9. Hoods
 - 10. Scoreboards
 - 11. Smoke Dampers
 - 12. Site Signs
 - 13. Ranges
 - 14. Dryers
 - 15. 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 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 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: 4/0 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. Wire Rod Type Cable Tray (Section 260536): Provide #2 bare copper conductor, entire length of cable tray. Bond at 50' intervals.
- K. Identification: Provide tag on each ground conductor at bus to read as follows: "Caution – Ground Wire – Do not Remove". Provide I.D. marking of all conductors as per N.E.C.

3.4 FIELD QUALITY CONTROL

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

END OF SECTION 260526

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.
 - 3. Corrosive locations: PVC coated or fiber reinforced plastic.
 - 4. Pool Environment: aluminum or stainless steel.
- O. Coordinate with other mechanical, plumbing, sprinkler, and electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

- P. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports in compliance with NEC requirements.
- Q. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.
- R. Remove burrs from ends of pipe sleeves.
- S. Do not use bridle rings or tie-wraps to support cables. J-hooks are the only acceptable support method.

END OF SECTION 260529

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 THE CAVITY SPACE BETWEEN THE BLOCK AND BRICK VENEER AREAS. Conduit penetrations through this cavity are to be installed directly into the back of the recessed flush mounted electrical outlet box/equipment back box. Conduit installations must be installed as required to minimize interference with the insulation/vapor barrier installations. The conduits shall be installed 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 260543 – UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit
- B. Duct
- C. Metallic Warning Tape
- D. 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 MANHOLE MANUFACTURERS

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

2.4 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.

2.5 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.

2.6 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.

2.7 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

2.8 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

2.9 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.

2.10 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.

2.11 REINFORCING FOR CONCRETE ENCASEMENT

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

2.12 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 FABRIC INNERDUCT INSTALLATION

- A. **Provide textile innerduct in conduit using continuous un-spliced lengths of textile innerduct between manholes, handholes, pull boxes, and/or termination points as indicated on the drawings.**
- B. **Make a 2" incision, approximately 18" from the end of textile innerduct. Pull out and cut off approximately 2' of pull-tape. Thus, allowing the pull tape ends to retract back into the cells.**
- C. **Using approximately 6' of pull tape, tie a non-slip knot to the incision. Then, tie 3 to 6 half-hitch knots down to the end of textile innerduct. Apply black vinyl tape over all knots and the end of textile innerduct. Using a Bow Line knot tie a swivel to the end of 3' pull tape. For multi-pack installations one swivel is sufficient but stagger each textile innerduct.**
- D. **Using a Bow Line knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install textile innerduct – ensuring that no twist is introduced to the innerduct.**
- E. **Provide suitable textile innerduct slack in the manholes, handholes, pull boxes, and/or termination points and at turns to ensure there is no kinking or binding of the product.**
- F. **Provide conventional plastic cable ties through previously created incisions.**
- G. **Maintenance Hole and Hand Hole Installation:**
 - 1. **At locations where textile innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault maintaining the minimum bend radius.**
 - 2. **At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault.**
- H. **Seal all conduit and textile innerduct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids, or rodents.**

3.7 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.

3.8 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.

3.9 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.

3.10 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.

3.11 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.

3.12 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)
 13. Area Protection Panels

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.

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: PPL Utilities
- 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. PPL Utilities: The Utility Company will furnish and install, via the underground ducts the primary and secondary service entrance conductors and make final connections at the transformer and building service entrance equipment.

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.

DISTRIBUTION PANEL			Bus:	1200A	Additional Notes	
MDP			Main Type:	1200A Main Breaker	100% Neutral with Ground Bus	
			Features:	E,GF,AERS	Customer Meter	
			Volts:	120/208V, 3PH, 4W	Service Entrance Rated	
			Space:	As Shown		
			AIC:	42,000		
			Mounting:	Surface		
CKT.	Breaker		Type	Description	KVA	Notes
	Amp	Pole				
1	60	3	T	TVSS L1	-	1,2
2	225	3	E	Panel LP1	47.2	2
3	150	3	E	Panel LP2	21.4	2
4	225	3	E	Panel LP3	42.1	2
5	150	3	E	Panel LP4	40.5	2
6	400	3	E	Panel HF (via T-HF)	86.7	2
7	70	3	E	Panel LS1 (via ATS-LS)	4.5	2,10,11
9	225	3	E	Panel OS1 (via ATS-OS)	47.3	2
10	90	3	T	RTU-1	25.5	
11	100	3	T	RTU-2	28.0	
12	110	3	T	RTU-3	30.8	
13						
14	100	3	E	Spare		
15	225	3	E	Spare		
16	400	3	E	Spare		
17	100	3		Prepared Space		
18	225	3		Prepared Space		
19	400	3		Prepared Space		
Total Connected Load KVA:					374.0	

PANEL		Bus:	225A Main Lugs	Additional Panel Notes										
LP1		Volts:	120/208V, 3PH, 4W	100% Neutral with Ground Bus										
		Poles:	42 + 42	Integral TVSS L3										
		AIC:	42,000											
Section 1 of 2		Mounting:	Surface	Fed From: Distribution Panel MDP										
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.		
	Amp	Pole			A	B	C			Pole	Amp			
1	20	1	Ltg - 113,116,117,121-128,133-136,148		1.6	0.9			Rec - 101	1	20	2		
3	20	1	Ltg - 101,102,129-132,149,151			1.0	0.9		Rec - 102	1	20	4		
5	20	1	Ltg - 152-163					0.9	0.4	1	20	6		
7	20	1	Ltg - 103,104,112		1.1	0.7			Rec - 103	1	20	8		
9	20	1	Ltg - Corridors				0.9	0.9	Rec - 103	1	20	10		
11	20	2	Ltg - Pole Mounted	3				0.6	0.7	Rec - 103	1	20	12	
13					0.6	0.7			Rec - 103	1	20	14		
15	20	2	Ltg - Pole Mounted	3			0.4	1.1	Floorbox Rec - 103	1	20	16		
17								0.4	0.7	Floorbox Rec - 103	1	20	18	
19	20	1	Rec - 113,148		1.1	0.9			Rec - 104,105	1	20	20		
21	20	1	Rec - Refrigerator 148	4			1.0	0.9	Rec - 104	1	20	22		
23	20	1	Rec - Refrigerator 148	4					Floorbox Rec - 104	1	20	24		
25	20	1	Rec - Coffee Maker 148		1.4	0.7			Rec - 106-109	1	20	26		
27	20	1	Rec - Microwave 148				0.2	0.6	Rec - Water Cooler 109	1	20	28		
29	20	1	Rec - 148						Rec - 111,112	1	20	30		
31	20	1	Rec - 148		0.2	1.1			Rec - 116	1	20	32		
33	20	1	Rec - 121				0.9	0.9	Rec - 117	1	20	34		
35	20	1	Rec - 122						Rec - 111,118	1	20	36		
37	20	1	Rec - 123		0.9	0.6			Rec - UC Refrigerator 118	1	20	38		
39	20	1	Rec - 124,125				1.1	1.0	Overhead Door - 114	1	20	40		
41	20	1	Rec - 126						Rec - 149	1	20	42		
					17.0		15.1	15.1	Total Connected Load KVA:				47.2	KVA
					Phase Totals									

PANEL		Bus:	225A Main Lugs		Additional Panel Notes							
LP1		Volts:	120/208V, 3PH, 4W		100% Neutral with Ground Bus							
		Poles:	42 + 42		Integral TVSS L3							
		AIC:	42,000									
Section 2 of 2		Mounting:	Surface		Fed From: Distribution Panel MDP							
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.
	Amp	Pole			A	B	C			Pole	Amp	
43	20	1	Rec - 127		0.9	0.9			Rec - 151	1	20	44
45	20	1	Rec - 119,128				0.9	1.0	Rec - Copier 151	1	20	46
47	20	1	Rec - 129						Rec - 152	1	20	48
49	20	1	Rec - 130		0.9	0.7			Rec - 153	1	20	50
51	20	1	Spare					0.9	Rec - 155	1	20	52
53	20	1	Motorized Shades - 103						Lighting Control Panel - 115	1	20	54
55	20	1	Rec - 100,101		0.7	0.4			Ltg - Exterior Building Sign	1	20	56
57	20	1	Rec - Board Room AV Rack									58
59	20	1	Rec - Board Room AV Rack					0.5				60
61												62
63												64
65												66
67												68
69												70
71												72
73	15	1	Spare						4 Spare	1	20	74
75	20	1	Spare						Spare	2	20	76
77	20	1	Spare									78
79	20	1	Spare						Spare	3	20	80
81	20	1	Spare									82
83	20	1	Spare									84
					17.0		15.1					
							15.1					
							Phase Totals				Total Connected Load KVA:	
											47.2 KVA	

(Addendum 4)
(Addendum 5)

PANEL		Bus:	225A Main Lugs		Additional Panel Notes								
LP2		Volts:	120/208V, 3PH, 4W		100% Neutral with Ground Bus								
		Poles:	42		Integral TVSS L3								
		AIC:	42,000										
		Mounting:	Surface		Fed From: Distribution Panel MDP								
CKT.	Breaker	Description	Notes	Load			Notes	Description	Breaker		CKT.		
	Amp			Pole	A	B			C	Pole		Amp	
1	15	1	VAV-4,8,18,34 - 111,117,121,122,123		0.6	1.2				Boiler B-2	1	20	2
3	15	1	VAV-16,27,30,31,32,33 - 105,111,112,113,127				0.6			Spare	1	20	4
5	15	1	VAV-3,5,11,23,29,XX - 119,120,126,130					0.6		Spare	1	20	6
7	15	1	VAV-1,8,11,13,14,16 - 102,109,150,151		0.6	3.0				Heating HW Loop Pump CP-2	3	50	8
9	15	1	CUH-1, UH-1 - 110,112				0.2	3.0					10
11	15	1	CUH-1, UH-1 - 100,114					0.2	3.0				12
13	15	1	FPV-1 - 105		1.0	1.5				EPWH-1 - 115	1	20	14
15	15	1	FPV-2 - 101				1.0	0.2		DWH-1 - 114	1	15	16
17	15	1	EF-4 - 114					0.2	0.2	DWH-2 - 114	1	15	18
19	15	1	EF-5 - Rooftop		0.4	0.2				DWH-3 - 114	1	15	20
21	15	1	Spare					0.5		Circ Pump CP-1	1	15	22
23	15	1	Spare						0.5	Circ Pump CP-2	1	15	24
25						0.9				Boiler Circ Pump CP-4	3	15	26
27								0.9					28
29									0.9				30
31	20	1	Spare							Spare	3	30	32
33	20	1	Spare										34
35	15	2	Spare										36
37										Spare	3	60	38
39	20	2	Spare										40
41													42
					9.4		6.4		5.6		Total Connected Load KVA:		
					Phase Totals					21.4		KVA	

(Addendum 4)

PANEL		Bus:	225A Main Lugs	Additional Panel Notes									
LP3		Volts:	120/208V, 3PH, 4W	100% Neutral with Ground Bus									
		Poles:	42 + 42	Integral TVSS L3									
		AIC:	42,000										
Section 1 of 2		Mounting:	Surface	Fed From: Distribution Panel MDP									
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.	
	Amp	Pole			A	B	C			Pole	Amp		
1	20	1	Ltg - 137-139,143,177-179		0.8	0.9			Rec - 157			2	
3	20	1	Ltg - 164-173,175,176				1.0	1.1	Rec - 150,159			4	
5	20	1	Ltg - Corridors						Rec - 161			6	
7	20	1	Spare					0.9	Rec - 163			8	
9	20	1	Spare						Rec - 164			10	
11	20	1	Spare						Rec - 165			12	
13	20	1	Rec - 120,131		1.1	1.1			Rec - 166			14	
15	20	1	Rec - 132				0.9	0.9	Rec - 167			16	
17	20	1	Rec - 133						Rec - 168			18	
19	20	1	Rec - 120,134		0.9	0.9			Rec - 169			20	
21	20	1	Rec - 135,136				1.1	0.9	Rec - 170			22	
23	20	1	Rec - 137						Rec - 171			24	
25	20	1	Rec - 138,141		1.1	1.3			Rec - 172			26	
27	20	1	Rec - 139				0.9	1.3	Rec - 173			28	
29	20	1	Rec - 143						Rec - 175			30	
31	20	1	Rec - 144-147		0.9	1.1			Rec - 176			32	
33	20	1	Rec - Water Cooler 119	4			0.6	0.9	Rec - 177			34	
35	20	1	Rec - 154						Rec - 177			36	
37	20	1	Rec - 119,156		1.1	0.9			Rec - 178			38	
39	20	1	Rec - 158				0.9	0.9	Rec - 178			40	
41	20	1	Rec - 160						Rec - 179			42	
					15.1			13.6	Total Connected Load KVA:			KVA	
								13.4	42.1			KVA	

PANEL		Bus:	225A Main Lugs		Additional Panel Notes									
LP3		Volts:	120/208V, 3PH, 4W		100% Neutral with Ground Bus									
		Poles:	42 + 42		Integral TVSS L3									
		AIC:	42,000											
Section 2 of 2		Mounting:	Surface		Fed From: Distribution Panel MDP									
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.		
	Amp	Pole			A	B	C			Pole	Amp			
43	20	1	Rec - 162		1.1	0.6			VAV-1,5,19,20,21,28 - 120,140	1	15	44		
45							0.6		VAV-1,3,23,25,26,27 - 174,175	1	15	46		
47								0.6	VAV-2,3,6,22,23,24 - 174,166	1	15	48		
49						0.4			VAV-10,11,12,17 - 119,174	1	15	50		
51									VAV-4,7,9,11,15 - 150,157,159,161,163,164,165	1	15	52		
53							0.7		EF-2 - 174	1	15	54		
55												56		
57												58		
59												60		
61												62		
63												64		
65												66		
67												68		
69												70		
71												72		
73	15	1	Spare						4	Spare	1	20	74	
75	20	1	Spare							Spare	2	20	76	
77	20	1	Spare										78	
79	20	1	Spare							Spare	3	20	80	
81	20	1	Spare										82	
83	20	1	Spare										84	
					15.1			13.6	13.4	Total Connected Load KVA:			42.1	KVA
										Phase Totals				

PANEL		Bus:	225A Main Lugs		Additional Panel Notes							
LP4		Volts:	120/208V, 3PH, 4W		100% Neutral with Ground Bus							
		Poles:	42 + 42		Integral TVSS L3							
		AIC:	42,000									
Section 1 of 2		Mounting:	Surface		Fed From: Distribution Panel MDP							
CKT.	Breaker	Description	Notes	Load			Notes	Description	Breaker		CKT.	
	Amp			Pole	A	B			C	Pole		Amp
1	20 1	Ltg - 004,018-020		1.0	1.1			Rec - 001,002,015	1	20	2	
3	20 1	Ltg - 002,003,005-014,021				1.2	0.6	Rec - Water Cooler 002	1	20	4	
5	15 1	UH-1,2 - 019,020					0.4	0.9	Rec - 013,014	1	20	6
7	15 1	VAV-5,27 - 002,003,004,018		0.4	1.1			Rec - 009A,010A,011,012	1	20	8	
9	15 1	CUH-2,4 - 001,005				0.2	1.0	Rec - Ice Bin 012	1	20	10	
11	15 1	ERU-1 - 009					0.8	1.0	Rec - Ice Bin 011	1	20	12
13	15 1	ERU-2 - 010		0.8	0.6			Rec - Water Cooler 021	1	20	14	
15	20 1	Rec - 005				0.2	0.7	Rec - 004	1	20	16	
17	20 1	Rec - 005					0.2	1.3	Rec - 018	1	20	18
19	20 1	Rec - 005		0.4	1.1			Rec - 003	1	20	20	
21	20 1	Rec - 005				0.2	0.9	Rec - 019	1	20	22	
23	20 1	Rec - 005					0.2	0.9	Rec - 020	1	20	24
25	20 1	Rec - 005		0.2	0.9			Rec - 020	1	20	26	
27	20 1	Rec - Drink Cooler	4			1.0	1.0	Overhead Door - 020	1	20	28	
29	20 1	Rec - 005					0.2	1.0	Rec - Washer 019	1	20	30
31	20 2	CU-1		1.0	2.5			Rec - Dryer 019	2	30	32	
33						1.0	2.5				34	
35	20 2	CU-2						Rec - 009	1	20	36	
37				1.0	0.7			Rec - 010	1	20	38	
39	20 2	DSS-1/CU-3 - 011				1.0	1.0	DSS-2/CU-4 - 012	2	20	40	
41											42	
				14.6	13.8		12.1	Total Connected Load KVA:				40.5 KVA
				Phase Totals								

(Addendum 4)

PANEL		Bus:	225A Main Lugs		Additional Panel Notes								
LP4		Volts:	120/208V, 3PH, 4W		100% Neutral with Ground Bus								
		Poles:	42 + 42		Integral TVSS L3								
		AIC:	42,000										
Section 2 of 2		Mounting:	Surface		Fed From: Distribution Panel MDP								
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.	
	Amp	Pole			A	B	C			Pole	Amp		
43	15	2	SSU-1 - 009		0.4	0.4			EF-3 - 020	1	15	44	
45						0.4	0.4		CUH-3,4 - 012,013,014,021	1	15	46	
47	15	2	SSU-2 - 010					0.4	0.6	4	20	48	
49					0.4	0.6			4	20	20	50	
51	20	1	Rec - Turf Field AV Rack - 019				0.5					52	
53	20	1	Rec - Turf Field AV Rack - 019					0.5				54	
55												56	
57												58	
59												60	
61												62	
63												64	
65												66	
67	15	1	Spare						Spare	2	15	68	
69	15	1	Spare									70	
71	20	1	Spare						Spare	2	20	72	
73	20	1	Spare									74	
75	20	1	Spare						Spare	2	30	76	
77	20	1	Spare									78	
79	20	1	Spare						Spare	3	20	80	
81	20	1	Spare									82	
83	20	1	Spare	4								84	
					14.6		13.8		12.1		Total Connected Load KVA:		
					Phase Totals							40.5	KVA

(Addendum 4)
(Addendum 5)

PANEL		Bus:	Additional Panel Notes									
HF		Volts:	100% Neutral with Ground Bus									
		Poles:	Integral TVSS L3									
		AIC:	NEMA 3R Enclosure									
		Mounting:	Fed From: Distribution Panel MDP (via T-HF)									
CKT.	Breaker Amp Pole	Description	Notes	Load			Notes	Description	Breaker Pole Amp		CKT.	
1	30 3	FH/Soccer - Pole S1		3.0	3.8			MP Field - Pole S5	3	30	2	
3						3.0	3.8				4	
5							3.0	3.8			6	
7	30 3	FH/Soccer - Pole S2		3.0	3.8			MP Field - Pole S6	3	30	8	
9						3.0	3.8				10	
11							3.0	3.8			12	
13	30 3	FH/Soccer - Pole S3		3.0	3.8			MP Field - Pole S7	3	30	14	
15						3.0	3.8				16	
17							3.0	3.8			18	
19	30 3	FH/Soccer - Pole S4		3.0	3.8			MP Field - Pole S8	3	30	20	
21						3.0	3.8				22	
23							3.0	3.8			24	
25											26	
27											28	
29											30	
31											32	
33											34	
35											36	
37											38	
39	60 2	Panel LF	2			2.8					40	
41							2.3				42	
				27.2			30.0	29.5	Total Connected Load KVA:			86.7 KVA
							Phase Totals					

MINI POWER-ZONE		Pri Bus:	60A Main Breaker	Additional Panel Notes										
		Pri Volts:	480V	100% Neutral with Ground Bus										
		Sec Bus:	80A Main Breaker	Square D Mini-Power Zone Model MPZB15S40F										
		Sec Volts:	120/240V, 1PH, 3W	NEMA 3R										
		Poles:	24	Provide XR Surge Protective Device										
		AIC:	10,000											
		Mounting:	Surface	Fed From: Panel HF (via Integral Transformer)										
CKT.	Breaker Amp	Pole	Description	Notes	Load		Notes	Description	Breaker		CKT.			
					A	B			Pole	Amp				
1	20	1	Rec - FH/Soccer Pole S1	3	0.2	0.2		3	Rec - MP Field Pole S5	1	20	2		
3	20	1	Rec - FH/Soccer Pole S2	3			0.2	0.2	3	Rec - MP Field Pole S6	1	20	4	
5	20	1	Rec - FH/Soccer Pole S3	3	0.2	0.2			3	Rec - MP Field Pole S7	1	20	6	
7	20	1	Rec - FH/Soccer Pole S4	3			0.2	0.2	3	Rec - MP Field Pole S8	1	20	8	
9	20	1	Musco Lighting Controller	3	0.5				Spare	2	20	10		
11	20	2	Scoreboard - FH/Soccer	3			1.0					12		
13					1.0	0.5			MP Field Network Switch + Recp	1	20	14		
15	20	1	FH/Soccer Network Switch + Recp	3			0.5					16		
17												18		
19												20		
21	30	2	XR Surge Protective Device	1					Spare	1	20	22		
23									Spare	1	20	24		
				2.8		2.3		Total Connected Load KVA:					5.1	KVA
				Phase Totals										

(Addendum 5)

PANEL		Bus:	Additional Panel Notes													
LS1		Volts:	100% Neutral with Ground Bus													
		Poles:	Integral TVSS L2													
		AIC:														
(LIFE-SAFETY)		Mounting:	Fed From: MDP and Generator (via ATS-LS)													
CKT.	Breaker	Description	Notes	Load			Notes	Description	Breaker		CKT.					
	Amp			Pole	A	B			C	Pole		Amp				
1	15	1	Emer Ltg - Basement, Stair	9	1.2	0.5			9	Exit Signs - Basement	1	15	2			
3	15	1	Emer Ltg - Exterior Bldg Mtd	9		0.8	0.5		9	Exit Signs - 1st Floor	1	15	4			
5	15	1	Emer Ltg - 1st Floor	9			1.2						6			
7	15	1	Emer Ltg - Board & Conf. Rms		0.3								8			
9													10			
11													12			
13													14			
15													16			
17													18			
19													20			
21													22			
23													24			
25	15	1	Spare							Spare	1	15	26			
27	15	1	Spare							Spare	1	15	28			
29	15	1	Spare							Spare	1	15	30			
										Total Connected Load KVA:				4.5	KVA	
										Phase Totals						
										2.0	1.3	1.2				

PANEL		Bus:	225A Main Lugs		Additional Panel Notes									
OS1		Volts:	120/208V, 3PH, 4W		100% Neutral with Ground Bus									
		Poles:	42		Integral TVSS L2									
		AIC:	10,000											
(OPTIONAL-STANDBY)		Mounting:	Surface		Fed From: MDP and Generator (via ATS-OS)									
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.		
	Amp	Pole			A	B	C			Pole	Amp			
1	20	1	Ltg - 106-108,114,115,118		0.5	0.5			3	Generator Battery Charger	1	20	2	
3	20	1	Rec - 115			0.4	1.0		3	Generator Battery Heater	1	20	4	
5	20	1	Rec - 114					1.1	3	Generator Block Heater	2	30	6	
7	20	1	Rec - 114		0.5	1.0							8	
9	20	1	Door Hardware Power				0.5	3.3	3	Grinder Pump	2	50	10	
11	20	1	Door Hardware Power					0.5					12	
13	20	1	Fire Alarm Control Panel - 114	7	1.0	1.2				Boiler B-1	1	20	14	
15	20	1	Area of Rescue Panel - 101	7			0.5	0.5		BAS Panel - 114	1	20	16	
17	20	1	Spare						3	Pole Mount Camera Enclosure	1	20	18	
19	15	3	Boiler Circ Pump CP-3 - 114		0.9	3.0				Heating HW Loop Pump CP-1	3	50	20	
21							0.9	3.0					22	
23								0.9					24	
25	50	3	Domestic Booster Pump - 114		2.9	3.0			2,12	Panel OS2	3	100	26	
27							2.9	3.7					28	
29									2.9	2.4			30	
31	15	1	Spare						4	Spare	1	20	32	
33	20	1	Spare							Spare	2	50	34	
35	20	1	Spare										36	
37	20	1	Spare							Spare	3	35	38	
39	20	1	Spare										40	
41	20	1	Spare										42	
					14.5			16.7		16.1		Total Connected Load KVA: 47.3 KVA		
					Phase Totals									

(Addendum 4)
(Addendum 5)

PANEL		Bus:	225A Main Lugs	Additional Panel Notes										
OS2		Volts:	120/208V, 3PH, 4W	100% Neutral with Ground Bus										
		Poles:	30	Integral TVSS L2										
		AIC:	10,000											
(OPTIONAL-STANDBY)		Mounting:	Surface	Fed From: Panel OS1										
CKT.	Breaker		Description	Notes	Load			Notes	Description	Breaker		CKT.		
	Amp	Pole			A	B	C			Pole	Amp			
1	20	1	Ltg - 142,144-147		0.2	1.0			DSS-3/CU-5 - 142	2	20	2		
3	20	1	Door Hardware Power - Basement			0.4	1.0					4		
5	20	1	Door Hardware Power - Basement					0.4	0.5	Rec - Data Rack 142	1	20	6	
7	20	1	Door Hardware Power - Basement, Vault		0.4	0.5				Rec - Data Rack 142	1	20	8	
9	20	1	Fire Alarm Signal Extender Panel - 142	7			0.5	0.4		Rec - 142	1	20	10	
11	20	1	Access Control Panel - 142					0.4	0.2	Rec - 142	1	20	12	
13	20	1	Intrusion Detection Panel - 142		0.5	0.4				Rec - 142	1	20	14	
15	20	2	Ltg - Pole Mounted	3			0.4	0.5		BAS Panel - 166	1	20	16	
17								0.4	0.5	BAS Panel - 019	1	20	18	
19	15	1	Spare							Spare	1	20	20	
21	20	1	Pole Mount Camera Enclosure	3			0.5			Spare	2	20	22	
23	20	1	Spare										24	
25	20	1	Spare							Spare	3	20	26	
27	20	1	Spare										28	
29	20	1	Spare										30	
					3.0		3.7		2.4	Total Connected Load KVA:			9.1	KVA
					Phase Totals									

(Addendum 5)

PANEL NOTES	
1	Provide conductors, overcurrent device and exact placement as recommended by the TVSS manufacturer.
2	Refer to Power Riser Diagram for wire and conduit sizes.
3	Refer to Site Plan for wire and conduit sizes.
4	Provide groundfault breaker for personal protection.
5	Provide groundfault breaker for equipment protection.
6	Provide a permanently fastened pad lockable breaker accessory for servicing.
7	Provide Space Age Electronics Model ELOCK-FA for breaker to lock in the ON position and identify breaker.
8	Provide a handle to lock in the on position.
9	Provide 2#10 + 1#10 gnd in 3/4" conduit for voltage drop.
10	Provide electronic mission critical breaker with minimum 225A sensor that selectively coordinates with all upstream and downstream overcurrent devices.
11	Provide with minimum 225A sensor and breaker type that is listed by ATS-LS manufacturer to meet the required WCR/AIC ratings. EC to coordinate as needed.
12	Provide electronic trip breaker with Long Time, Short Time, and Instantaneous adjustments.
13	

SWITCHBOARD/DISTRIBUTION PANEL BREAKER TYPES	
T	Thermal Magnetic
E	Electronic Trip with Long Time, Short Time, Instantaneous Setting Adjustments
ZSI	Zone-Selective Interlocking
EP	Energy/Power Trip Unit with Long Time, Short Time, Instantaneous Setting Adjustments, Zone Selective Interlock, Breaker Status Display & Modbus Wired Communications
GF	Ground Fault Protection
ST	Shunt Trip breaker accessory
HC	Permanently fastened pad lockable breaker accessory for servicing
AERS	Arc Energy Reduction Switch per NEC 240.87

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

SECTION 260650 - LUMINAIRE SCHEDULE

Mark	Manufacturer	Catalog Number	Description	Volts	Lamps			Driver		Mtg. Height	Notes
					No.	Watts	Type/ Lumens	No.	Type		
OC1	Gardco eLuminaire LSI	SFCR-DD-5W-48L-400-WW-G2- UNV-MGY-DL RCS1 Series XSPS Series	LED Canopy Fixture	UNV	1	60	LED 4897	1	DLD	SC	
OP1	LSI Gardco NLS Lithonia McGraw-Edison	MRS-LED-06L-SIL-3-UNV-DIM-30- 70CRI-IMSBT1L-XX OPF Series NV Series RSX1 Series GLEON Series	LED Single Head Pole Mount Site Light w/ Integral Motion Sensor - Type 3	UNV	1	39	LED 6016	1	DLD	PM	6,10,13
OP2	LSI Gardco NLS Lithonia McGraw-Edison	MRS-LED-09L-SIL-3-UNV-DIM-30- 70CRI-IMSBT1L-XX OPF Series NV Series RSX1 Series GLEON Series	LED Single Head Pole Mount Site Light w/ Integral Motion Sensor - Type 3	UNV	1	63	LED 9241	1	DLD	PM	6,11,13
OP3	LSI Gardco NLS Lithonia McGraw-Edison	MRS-LED-09L-SIL-5W-UNV-DIM- 30-70CRI-IMSBT1L-XX OPF Series NV Series RSX1 Series GLEON Series	LED Single Head Pole Mount Site Light w/ Integral Motion Sensor - Type 5	UNV	1	63	LED 8740	1	DLD	PM	6,11,13
OP4	LSI Gardco NLS Lithonia McGraw-Edison	MRS-LED-09L-SIL-4-UNV-DIM-30- 70CRI-IMSBT1L-XX OPF Series NV Series RSX1 Series GLEON Series	LED Single Head Pole Mount Site Light w/ Integral Motion Sensor - Type 4	UNV	1	63	LED 9214	1	DLD	PM	6,11,13

Mark	Manufacturer	Catalog Number	Description	Volts	Lamps			Driver		Mtg. Height	Notes
					No.	Watts	Type/ Lumens	No.	Type		
OP5	LSI	MRS-LED-06L-SIL-2-UNV-DIM-30-70CRI-IMSBT1L-XX	LED Single Head Pole Mount Site Light w/ Integral Motion Sensor - Type 2	UNV	1	39	LED 5918	1	DLD	20'-0"	6,10,13
	Gardco	OPF Series									
	NLS	NV Series									
	Lithonia	RSX1 Series									
OP6	McGraw-Edison	GLEON Series	LED Single Head Pole Mount Site Light w/ Integral Motion Sensor - Type 5	UNV	1	111	LED 14304	1	DLD	20'-0"	6,11,13
	LSI	MRS-LED-15L-SIL-5W-UNV-DIM-30-70CRI-IMSBT1L-XX									
	Gardco	OPF Series									
	NLS	NV Series									
OR1	Lithonia	RSX1 Series	6" Round Downlight – Medium Distribution	UNV	1	20	LED 1705	1	DLD	RC	6
	McGraw-Edison	GLEON Series									
	Gotham	EVO6-30/20-AR-LD-MD-MVOLT-GZ10									
	Maxilume	HH6 Series									
OW1	Prescolite	LFR-6RD Series	Exterior LED Wall-Mount Fixture w/ Type 3 Distribution	UNV	1	55	LED 4915	1	DLD	SW	See Notes
	Lightolier	P6R Series									
	Gardco	121-16L-1000-WW-G4-3-UNV-DD-XX									
	McGraw-Edison	ISC Series									
OW2	Lithonia	WST Series	Exterior LED Wall-Mount Fixture w/ Type 3 Distribution	UNV	1	28	LED 2885	1	DLD	SW	See Notes
	Beacon	VPW Series									
	NLS	NV-W Series									
	Gardco	121-16L-530-WW-G4-3-UNV-DD-XX									
OW2	McGraw-Edison	ISC Series	Exterior LED Wall-Mount Fixture w/ Type 3 Distribution	UNV	1	28	LED 2885	1	DLD	SW	See Notes
	Lithonia	WST Series									
	Beacon	VPW Series									
	NLS	NV-W									

Mark	Manufacturer	Catalog Number	Description	Volts	Lamps			Driver		Mtg. Height	Notes
					No.	Watts	Type/ Lumens	No.	Type		
OW3	Ligman Lithonia Beacon FC Lighting	UQU-XX-T3-W30-XX-120/277V-F WDGE Series VPW Series FCW1029 Series	Exterior LED Wall Mount Fixture w/ Type 3 Distribution	UNV	1	20	LED 2500	1	DLD	SW 10'-0"	6,7,8,9
CH1	Oracle Lithonia Williams Metalux Day-Brite	4-OCLE-5000L-DIM10-MVOLT- 35K-85-OVCH ZL1D Series 76R Series SNLED Series FLP Series	4' LED Industrial	UNV	1	37	LED 5253	1	DLD	CH 8'-0" min	1,5
EM1	Evenlite Lithonia Emergi-Lite Sure-Lites Chloride	TCL-2-W-SD ELM2 EL-2SQL Series SEL Series CLU Series	LED Emergency Lighting Battery Pack	UNV	2	1	LED 200	-	-	SW 7'-0" AFF	
EX1	Evenlite Lithonia Sure-Lites Emergi-Lite Chloride	SOVIL-AC-R-XX-BA-XX-XX EDG Series EUS Series LX Series 44R Series	LED Exit Sign Single/Dual Face	UNV	-	-	LED	-	-	SW/SC 2,3	
EX2	Evenlite Lithonia Emergi-Lite Sure-Lites Chloride	TWL-AC-R-XX-W LVS Series SVX Series UX6 Series CWE Series	High Abuse - LED Exit Sign Single/Dual Face	UNV	-	-	LED	-	-	SW/SC 2,3	
P1	Focal Point Mark Coronet Ledalite Axis	FSM2BS-BWPD05-875DN-250UP- 35K-1C-UNV-L11-CXX-WH S2PID Series LS3 Series 29 Series TB2DILED Series	LED 3" Wide Linear Direct/Indirect Pendant (Conference)	UNV	1	10 Per 1'	LED 1250 Per 1'	1	DLD	AH 8'-0"	4,5,6,7

Mark	Manufacturer	Catalog Number	Description	Volts	Lamps			Driver		Mtg. Height	Notes
					No.	Watts	Type/ Lumens	No.	Type		
P2	ALW Zaneen Camman	MR3-D5-CAS-LOW/90/3500K-V01-LENS-MED/90/3500K-LENS-XX-UNV A30315 Series P1044 Series	61" Diameter Round Direct/Indirect Pendant (Board Room)	UNV	1	107.7	LED 14777	1	DLD	AH 10'-0"	4,6
RC1	Williams Lithonia Oracle Day-Brite	BP-2-4-LS-8-CS-DIM-UNV CPANL Series 24-FPL-BL-LED Series 2FPZ Series	2'x4' LED Edgelit Flat Panel	UNV	1	38.5	LED 4700	1	DLD	RC	12
RC2	Williams Lithonia Oracle Day-Brite	BP-1-4-LS-8-C-DIM-UNV CPANL Series 14-FPL-BL-LED Series 2FPZ Series	1'x4' LED Edgelit Flat Panel	UNV	1	39.9	LED 4660	1	DLD	RC	12
RC3	Williams Lithonia Oracle Day-Brite	BP-2-2-LS-8-C-DIM-UNV CPANL Series 22-FPL-BL-LED Series 2FPZ Series	2'x2' LED Edgelit Flat Panel	UNV	1	41.2	LED 4543	1	DLD	RC	12
RC4	Focal Point Litecontrol 3G-Lighting Lumenwerx Axis	FSM4PR-ALH-AF0-875LF-35K-1G-UNV-LD1-XX-WH-XX 6L-RD-Series 3G-4RPE-Series V3PERx-Series BBPRLED-Series	4" Linear Recessed Perimeter (Toilets)	UNV	1	9 per 1'	LED 875 per 1'	1	DLD	RC	5
RD1	Gotham Maxilume Prescolite Lightolier	EVO6-35/20-AR-LD-MD-MVOLT-GZ1 HH6 Series LFR-6RD Series P6R Series	6" Round Downlight – Medium Distribution	UNV	1	20	LED 1705	1	DLD	RC	6
RD2	3G-Lighting	3G-DL33RA-22-H90-35K-60D-UNV-D01-XX-XX-NGF-SF	4" Round Adjustable Downlight – Medium Distribution	UNV	1	22.5	LED 1566	1	DLD	RC	6

Mark	Manufacturer	Catalog Number	Description	Volts	Lamps			Driver		Mtg. Height	Notes
					No.	Watts	Type/ Lumens	No.	Type		
SC1	Luminaire LED Kenall	VPF8-4FT-MIN1-50W-35K-MVOLT-OP-XX MLHA8 Series	4' Vandal Resistant Surface Mount Wraparound (Stairwells)	UNV	1	53.3	LED 5736	1	DLD	SC	
SD1	3G Lighting CSL Alphabet	3G-DL40SA-20-H95-35K-40D-UNV-D01-XX-XX-NCF-SF A4 Series NUE4QA Series	4" Square Adjustable Downlight – Medium Distribution	UNV	1	20	LED 2000	1	DLD	RC	6
SW1	Williams Amico	WMAUD-4-L30/835U/L30/835D-AF-DIMU/DIMD-UNV L-SKY Series	4' LED Wall Mount Direct/Indirect	UNV	1	46.6	LED 6174	1	DLD	SW	6

Driver & Ballast Legend	
Symbol	Description
DLD	Dimming LED Driver, 0-10 volts.
LD	LED driver.
1LE	One lamp electronic
2LE	Two lamp electronic
3LE	Three lamp electronic
4LE	Four lamp electronic
FD	Fluorescent dimming as specified.
HID	Magnetic HID
DMX	DMX Dimming Driver

Mounting Legend			
Symbol	Description	Symbol	Description
RC	Recessed Ceiling	S	Suspended
RW	Recessed Wall	UC	Under Cabinet
SC	Surface Ceiling	PD	Per Detail on Drawings
SW	Surface Wall	PM	Pole Mounted
CH	Chain Hung	IG	Recessed In-Ground
AH	Aircraft Cable Hung	PT	Pole Top Mounted
P	Pendant	T	Track
WB	Wall Bracket	B	Bollard
SF	Surface Floor		

General Notes	
G1	Check descriptions against catalog numbers. Report any discrepancies prior to submitting a proposal for this work.
G2	Where the listed manufacturer of acceptable substitutes makes more than one grade of the fixture, provide the grade of fixture with equal or better construction, materials and performance as determined by the manufacturer.
G3	Engineer must approve all substitutes prior to bid.
G4	All Recessed 1x4, 2x2 and 2x4 fixtures shall have spring-loaded latches. Cam action (friction) latches are not acceptable.
G5	All drivers/ballasts shall be Universal 120-277 voltage. If universal driver is unavailable, furnish 277 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.
G8	The luminaire schedule was developed with three or more equals to provide a competitive bidding climate. In certain circumstances, some luminaires are deemed proprietary due to local ordinance specifications or performance characteristics where alternate manufacturers cannot meet the requirements of the basis of design. In these cases where it is noted "No substitutions," the electrical distributors shall have the authority to require unit pricing from the manufacturer's representative in order to assemble the most competitive lump sum price for the luminaire package. Manufacturer representatives who fail to comply with this requirement risk changes to the luminaire schedule.

Luminaire Notes	
1	Provide stem/chain size as required.
2	Provide single or double faces as required.
3	Provide all additional mounting accessories for each application.
4	Provide aircraft cable length as required.
5	Provide continuous lengths as shown on the drawings.
6	Architect to select finish of luminaire. Provide color samples with submittals to Architect for review and selection.
7	Locations/Heights shown on Electrical Drawings are approximate. Coordinate exact mounting height and location with Architectural Elevations. Review with Architect before rough-in.
8	Review all field locations with Architect before rough-in.
9	Provide with custom 2500 lumen output.
10	Provide 13' aluminum square pole with individual bolt covers. Provide pole base per Detail 8/E7.1 on the Drawings to mount pole and luminaires.
11	Provide 17' aluminum square pole with individual bolt covers. Provide pole base per Detail 8/E7.1 on the Drawings to mount pole and luminaires.
12	Set adjustable wattage to 40W output and color temperature to 3500K.
13	Basis of Design – Building and Parking Lot fixtures meet the township ordinance requirements. Approved equal manufacturers will be required to submit Approval Drawings to the Township and Engineer showing building and site layout, point by point calculation results and catalog cuts verifying photometric properties of luminaries. Final approval will only be given after these items are submitted.

END OF SECTION 260650

(Addendum 4)
(Addendum 5)

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. 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.
2. 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.
3. 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.

4. 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 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.
- g. Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.

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: 1 for every 20 of each type installed. Furnish at least 1 of each type installed.
 - 2. Wall Switches: 1 for every 20 of each type and finish installed. Furnish at least 1 of each type and finished installed.
 - 3. Daylight Sensors: 1 for every 20 of each type installed. Furnish at least 1 of each type installed.
 - 4. Room Controllers: 1 for every 30 of each type installed. Furnish at least 1 of each type installed.
 - 5. Network Bridges: Furnish 2 of each type installed.
 - 6. 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: Watt Stopper Digital Lighting Management (DLM)
- B. Alternate manufacturers as listed below:
 - 1. Hubbell NX
- C. Alternate manufacturers subject to compliance with the following requirements:
 - 1. The performance and operating characteristics meet or exceed the Basis of Design.
 - 2. The alternate manufacturer shall include all features, accessories and additional equipment required for a complete installation.
 - 3. All requirements listed in the sequence of operation can be met by this system. If items cannot be met, deviations shall be listed in the submittal.
 - 4. The Electrical Contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring.
 - 5. The alternate manufacturer shall include all networking equipment that meets or exceeds the basis of design manufacturers equipment.
 - 6. Wireless equipment with batteries will not be acceptable.

2.2 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

- A. System General: Provide a Wattstopper Digital Lighting Management System (DLM) complete with all necessary enclosures, wiring, and system components to ensure a complete and properly functioning system as indicated on the Drawings and specified herein. If a conflict is identified between the Drawing and this Specification contact the Architect for clarification prior to proceeding.
 - 1. Default to project's determined Energy Code requirements and specifier's Sequence of Operation (SoO); otherwise follow below narrative:
 - 2. Space Control Requirements: Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality as indicated in all spaces except where hands-free operation is desirable and Automatic-ON occupancy sensors are allowed. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling, corner, or fixture mounted sensors, and set up for Manual-ON or Partial-On operation.
 - 3. Task Lighting / Plug Loads: Provide automatic shut off of non-essential plug loads and task lighting in spaces as required by the applicable energy code. Provide Automatic-ON of plug loads by time of day or occupancy sensors whenever spaces are occupied.
 - 4. Daylit Areas: Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code:
 - a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
 - b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.

- c. Multi-zone sensors may be utilized for daylight areas on the drawings.
 - d. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels.
- 5. Conference, meeting, training, auditoriums, and multipurpose rooms shall have independent control of local control zones. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that reconfigured the room based on specific partitioning.
- B. Local Room Communication Network: DLM communications in room can either be over a wireless IPv6 network, a wired Cat 5e network referred to as local network or In Room Bus (IRB), or a hybrid with wired Room Controllers, a wireless bridge, and additional wired and/or wireless accessory devices.
 - 1. Wired Room Network with LMRJ Cat 5e cables: DLM local or In Room Bus (IRB) network is a free topology lighting control physical connection and communication protocol designed to control a room or small area of building.
 - a. Features of the wired DLM local network include:
 - 1) Plug n Go automatic configuration and binding of occupancy sensors, switches, and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 - 2) Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration, or setup.
 - 3) Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 - 4) Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
 - b. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide digital communication from individual end devices are not acceptable.
 - c. If manufacturer's pre-terminated Cat5e cables are not used for the installation, each contractor terminated cable must be individually tested and logged provided to any authorized service representative following installation.
 - 2. Hybrid Room Network: local room network is formed using a combination of wired room controllers, a wireless bridge, and wired and/or wireless occupancy sensors and switches/dimmers.
 - a. Features of the Hybrid DLM local network include:
 - 1) A wireless network bridge is included in the room to act as a bridge between devices that use a wired local IRB network and the devices that use a wireless local PAN network.
 - 2) Wireless room devices utilize a trusted hardware chip to ensure that only the manufacture's products can access and participate in the wireless network.

- 3) Wireless bridge shall be capable of communicating with other wireless bridges, wired load controllers in the room, and a Secondary border router to enable a large-scale low power self-healing IPv6 mesh communication network between rooms in the PAN.

2.3 DIGITAL ROOM LIGHTING/PLUG CONTROLLERS GENERAL REQUIREMENTS

- A. Digital Load Controllers: Digital controllers for lighting zones, fixtures and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting and plug load control requirements. Controllers are simple to install, and do not have dip switches/potentiometers or require special configuration for standard Plug n' Go applications. Control units include the following features:
 1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room (Plug n Go)
 2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
 3. Multiple wired load controllers connected in a local wired IRB network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device serial number from highest to lowest.
 4. Device Status LEDs to Indicate:
 - a. Data transmission
 - b. Device has power
 - c. Status for each load
 - d. Configuration status
 5. Quick Installation Features Including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable
 6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
 - a. Turn on to 100 percent
 - b. Turn off
 - c. Turn on to last level
 7. Each load be configurable to operate in the following sequences based on occupancy:
 - a. Auto-on/Auto-off (Follow on and off).
 - b. Manual-on/Auto-off (Follow off only).
 8. Polarity of each load output shall be reversible, via digital configuration, so that an on command turns load off and an off command turns a load on.
 9. BACnet object information shall be available for the following objects:
 - a. Load status
 - b. Schedule state, normal or after-hours
 - c. Demand Response enable/disable
 - d. Room occupancy status
 - e. Total room lighting and plug loads watts
 - f. Electrical current
 - g. Total watts per controller
 - h. Total room watts/sqft.

10. UL 2043 plenum rated
11. LED On/Off status indication for each load
12. Zero cross circuitry for each load
13. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
14. Dimming Room Controllers shall share the following features:
 - a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours to allow different dimmed levels to be established.
 - b. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
 - c. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - 1) Establish preset level for each load from 0-100 percent.
 - 2) Set high and low trim for each load.
 - 3) Initiate lamp burn in for each load of either 0, 12 or 100 hours.
 - d. Override button for each load provides the following functions:
 - 1) Tap for on/off control.
 - 2) Press and hold for dimming control (lighting only).
 - e. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
 - f. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
 - g. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
15. All configurations shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dipswitches are not acceptable.

2.4 WIRED DIGITAL LIGHTING ROOM CONTROLLERS

- A. Wired On/Off/0-10V KO Mount Dimming Room Controllers Shall Include:
 1. Dual voltage (120/277 VAC, 50/60 Hz) capable rated for 10A total load, or 16A total load depending on product.
 2. Optional real time current and voltage metering (with - M Monitoring option).
 3. One or two relay configurations (10A) or one relay configuration (16A)
 4. Smart 150 mA switching power supply
 5. Two RJ-45 DLM local network ports. Provide molded strain relief ring
 6. One dimming output per relay
 - a. 0-10V Dimming - Where indicated, 0-10 volt analog outputs per relay for control of compatible ballasts and LED drivers. Units shall include a complimentary UL 924 rating for the ability of the 0-10 volt output to automatically open upon loss of power to the Room Controller to assure full light output from lighting connected to the 0-10V signal and powered by a live line voltage circuit.

7. Units capable of providing both Class 1 and/or Class 2 wiring for the 0-10V output
 8. Wattstopper Product Numbers: LMRC-111, LMRC-111-M, LMRC-112, or LMRC-112-M, or LMRC-111-16M.
 9. Provide wired digital lighting room controller quantities as shown on the Drawings.
- B. Wired On/Off/0-10V Dimming Enhanced Room Controllers Shall Include:
1. Dual voltage (120/277 VAC, 50/60 Hz) capable or 347 VAC, 50/60 Hz. 120/277 volt models rated for 20A total load; 347 volt models rated for 15A total load
 2. Built in real time current monitoring via transducer
 3. One, two or three relay configurations
 4. Smart 250 mA switching power supply
 5. Conduit adaptor available for applications where all wiring must be in conduit.
 6. Four RJ-45 DLM local network ports. Provide integral strain relief
 7. One dimming output per relay
 - a. 0-10V Dimming - Where indicated, 0-10 volt analog outputs per relay for control of compatible ballasts and LED drivers. Units shall include a complimentary UL 924 rating for the ability of the 0-10 volt output to automatically open upon loss of power to the Room Controller to assure full light output from lighting connected to the 0-10V signal and powered by a live line voltage circuit.
 8. Wattstopper product numbers: LMRC-211, LMRC-212, or LMRC-213.
 9. Provide wired digital lighting room controller quantities as shown on the Drawings.

2.5 INPUT PHASE CONVERTERS, 0-10 V

- A. When a project has loads that require phase dimming instead of 0-10 V dimming, include 0-10 V interface devices that monitors a 0-10 V signal from a room controller and, using that as an input, will alter the electrical sine wave to the loads by forward phase (leading edge) or reverse phase (trailing edge) dimming. These devices are interfaces acting on the line voltage circuits and will not have to communicate to other DLM devices in the area via Cat 5e or wireless communication.
- B. Use an Interface Device with Two 1/2 inch KO Mounting Nipples: One for the incoming and exiting line voltage circuit, and the other for the 0-10 V signaling wires. Unit will automatically sense whether the line voltage circuit is 120 or 277 VAC and provide a reverse phase only dimming switchleg. This device will handle loads of 450 W for 120 V and 1000 W for 277 V and have a molded polycarbonate body.
1. Wattstopper Part Number: LDCM-PL-120-277-010V.
- C. Use an interface device that uses a slotted bracket for surface mounting and is rated for install in plenum spaces. The device will automatically determine optimum dimming type for the load of either forward or reverse phase. This device will handle loads of 750W for 120V and 1300W for 277V.
1. Wattstopper part number BF-SDS10V-AST.
- D. Provide wired digital lighting room controller quantities as shown on the Drawings.

2.6 WIRED DIGITAL PLUG LOAD ROOM CONTROLLER

- A. Wired Plug Load Controllers shall include:
 - 1. Plug Load Controllers shall include:
 - 2. 120 VAC, 50/60 Hz rated for 20A total load. Some Controllers carry application-specific UL 20 rating for receptacle control.
 - 3. One relay configuration with additional connection for unswitched switchleg.
 - 4. Factory default operation (Plug 'n Go) is Auto-on/Auto-off, based on occupancy, and loads not bound automatically to any switches in room.
 - 5. Optional real time current, or current and voltage metering depending on unit. Metering shall provide a single total wattage measurement of both switched and unswitched switchleg wires in plug in loads.
 - 6. Switching Power Supply:
 - a. Simple 150mA - Only 4 100 series devices on a Cat 5e local network (LMRC-101 or -102, LMPL-101, LMPB-100). Limit devices to 24 total.
 - b. Smart 150mA (LMPL-111-20M).
 - c. Smart 250mA (LMPL-201).
 - 7. RJ-45 DLM Local Network Ports:
 - a. Two RJ-45 ports (LMPL-111-20M).
 - b. Three RJ-45 ports (LMPL-101).
 - c. Four RJ-45 ports (LMPL-201).
- B. Provide digital plug load room controller quantities as shown on the drawings.

2.7 WIRED DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

- A. Wired Digital Occupancy Sensors with two way digital communications to Lighting Control system. Provide sensors of quantity and type to meet specific room applications. Features include the following:
 - 1. Digital communication and pushbutton configuration of the following variables:
 - a. Sensitivity, 0-100 percent in 10 percent increments.
 - b. Time delay, 1-30 minutes in 1 minute increments.
 - c. Test mode, Five second time delay.
 - d. Detection technology, PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode.
 - 2. Load parameters settings include Auto or Manual-ON and blink warning.
 - 3. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes or implementing a Partial On or Partial Off Sequence of Operation.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes available for both Normal (NH) and After Hours (AH) time periods. The trigger and retrigger modes can be programmed to use the following technologies options:
 - 1) Ultrasonic and Passive Infrared.
 - 2) Ultrasonic or Passive Infrared.

- 3) Ultrasonic only.
 - 4) Passive Infrared only.
 - e. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal and After Hour time periods.
 4. One or two RJ-45 ports for connection to DLM local network.
 5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 6. Device Status LEDs, which may be disabled for selected applications, including:
 - a. PIR detection.
 - b. Ultrasonic detection.
 - c. Configuration mode.
 - d. Load binding.
 7. Optional lens configurations for the PIR only Wall and Ceiling sensors to allow coverage of longer ranges, 1 way or 2 way aisles, higher density coverage in smaller areas, or mounting up to 40 foot heights.
 8. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 9. Manual override of controlled loads is permitted.
 10. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
1. Detection state for each sensor.
 2. Detection state for all sensors in room (Room status).
 3. Occupancy sensor time delay.
 4. Occupancy sensor sensitivity, PIR and Ultrasonic.
- C. Units shall not have any dip switches or potentiometers for field settings.
- D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
- E. WattStopper Product Numbers:
1. Dual Technology Corner Mount:
 - a. LMDX-100
 - b. Usage: Classrooms or similar spaces with ceilings
 2. Dual Technology Ceiling Mount:
 - a. LMDC-100
 - b. Usage: Gang Toilet Rooms, Corridors, Offices, Conference Rooms, and similar spaces
 3. Passive Infrared Ceiling Mount – Extended Height Lens:
 - a. LMPC-100-5
 - b. Usage: Gymnasium or other rooms with ceilings over 15' high.
- F. Provide occupancy sensor quantities as shown on the Drawings.

- G. Provide an additional (10) occupancy sensors (type selected by Engineer) with wiring in addition to those shown on the Drawings for any dead spots with the current occupancy sensor layout. These will be added as needed during commissioning.

2.8 OCCUPANCY SENSOR PROTECTIVE CAGES

- A. Manufacturers:
 - 1. Watt Stopper Model WC-1, WC-2, WC-3, or WC-4
- B. Provide protective cages for all devices located in the Gymnasium and other areas shown on the Drawings.

2.9 WIRED DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8-button configuration. Wall switches shall include the following features:
 - 1. Buttons are used to control loads in a room, trigger scenes in a room, or control a network group of loads. Rockers are used to raise or lower the level of loads in a room.
 - 2. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - 3. Removable buttons/rocker insert for field replacement with engraved and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall, only the switch plate.
 - 4. Configuration LED on each switch that blinks to indicate data transmission.
 - 5. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
 - 6. Programmable control functionality including:
 - a. Button priority may be configured to any BACnet priority level, from 1-16, allowing local actions to utilize force on or functions associated with the other priority levels.
 - b. Scenes may be saved to any button other than dimming rockers. Once set, individual buttons may be digitally locked to prevent overwriting of the preset levels by an occupant in the room.
 - 7. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
 - 1. Button state
 - 2. Switch lock control
 - 3. Switch lock status
- C. Two RJ-45 ports for connection to DLM local network.

- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.
- E. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
 - 1. Individual button function may be configured to Toggle, On only, Off only, or , Toggle Dim (toggles between press and hold to raise, release, then press and hold to lower).
 - 2. Individual scene buttons may be locked to prevent unauthorized change.
 - 3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours in preset intervals.
 - 4. Ramp rate may be adjusted for each dimmer.
 - 5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
- F. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
- G. WattStopper Product Numbers:
 - 1. Single Button – LMSW-210
 - 2. Single Button Dimmer – LMSW-211
 - 3. Two Button – LMSW-220
 - 4. Two Button with Raise/Lower – LMSW-222
 - 5. Four Button with Raise/Lower – LMSW-241
 - 6. Five Button – LMSW-250
 - 7. Use legacy devices where used in a building with existing switches.
- H. Engraving:
 - 1. Provide custom engraving (ENG) for all wall switches to match the sequence of operation.
- I. Color:
 - 1. Match device color in Section 262726.
 - 2. Match wall plate type/color in Section 262726.
- J. Provide digital wall switch quantities as shown on the Drawings.

2.10 WIRELESS SLIM WALL SWITCHES

- A. Low voltage momentary pushbutton devices offered in two different families. All wireless wall switches shall include the following features:
 - 1. Wireless Switches shall provide two types of wireless communication:
 - a. IPv6 for device to device communication inside rooms.
 - b. Bluetooth Low Energy for communication to an APP running on local phone or tablet using iOS or Android operating system. Using the APP, the switches individual settings can be adjusted.
 - 2. Switches shall include a trusted hardware chip to ensure that only devices by the lighting control system provider can communicate with devices on the network.

3. Switches shall indicate low battery (2.5V or less) by lighting a red LED when button is pressed.
 4. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 5. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 6. Configuration button on device, and an LED that blinks to indicate data transmission.
 7. Removable ground wire included for when switches mounted in metal enclosure with line voltage devices separated by barrier.
 8. Programmable control functionality including:
 - a. Button priority configurable to BACnet priority levels 1-16 allowing local actions to utilize advanced scenarios
 - b. Scene patterns may be saved to any button other than dimming rockers.
 9. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- B. Multiple digital wall switches may be installed in a room. No additional configuration shall be required to achieve multi-way switching.
- C. Button function may be reconfigured for individual buttons from Load to Scene, or scene to load.
1. Individual button function may be configured to Toggle, On only or Off only.
 2. Switch buttons may be bound to any load on any load controller and are not load type dependent; each button may be bound to multiple loads.
- D. WattStopper Product Numbers:
1. Single Button Dimmer – LMSW-611-S
 2. Single Button – LMSW-610-S
 3. Two Button – LMSW-622-S
 4. Three Button – LMSW-632-S
 5. Four Button – LMSW-641-S
 6. Five Button with Raise/Lower – LMSW-605
- E. Color:
1. Match device color in Section 262726.
 2. Match wall plate type/color in Section 262726.
- F. Provide wireless slim wall switch quantities as shown on the Drawings.

2.11 WIRED DIGITAL DAYLIGHT SENSORS

- A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.

2. Open loop sensors measure incoming daylight in the space and can control up to three lighting zones.
- B. Digital daylighting sensors shall include the following features:
1. Sensor's internal photodiode shall only measure light within the visible spectrum. The photodiode's spectral response curve shall closely match the photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 or greater than 700 nanometers.
 2. Sensor light level range shall be from 1-1,533 foot-candles (fc).
 3. Capability of ON/OFF, bi-level, tri-level, or dimming for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
 4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband (separation, between the "ON Setpoint" and the "OFF Setpoint") to prevent the lights from cycling on and off excessively.
 5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
 6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
 7. Photosensors shall provide adjustable cut-off time. Cut-off time defined as the number of selected minutes the load is at the minimum output before the load turns off. Selectable range of 0-240 minutes including option for no cut-off.
 8. Wall switch functions so occupants may always reduce lighting level to increase energy savings or, if permitted by facility engineer, optionally raise lighting levels for a selectable period or cycle of occupancy above daylight cap level.
 9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool.
 10. Configuration LED status light on device blinks to indicate data transmission.
 11. Status LED indicates test mode, override mode and load binding.
 12. Recessed switch on device to turn controlled load(s) ON and OFF.
 13. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
 - a. Light level
 - b. Day and night setpoints
 - c. Off time delay
 - d. On and off setpoints
 - e. Up to three zone setpoints
 - f. Operating mode - on/off, bi-level, tri-level or dimming
 14. One RJ-45 port for connection to DLM local network.
 15. A choice of accessories to accommodate multiple mounting methods and building materials. Photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62 inch thick (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62 to 1.25 inches thick (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2).
 16. Any load or group of loads in the room can be assigned to a daylighting zone.

17. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
18. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

C. Provide photosensors (daylight sensors) as shown on the drawings.

2.12 WIRED DIGITAL PARTITION CONTROLS

- A. Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by changing the rooms profile and reconfiguring the loads controlled by any connected digital switches and occupancy sensors (excludes daylight sensors).
- B. Coordinate contact closure interface for automatic control via input from limit switches on movable walls specified in Section 10 22 33 - Accordion Folding Partitions
 1. Operates on Class 2 power supplied by DLM local network.
 2. Includes 24VDC output and four input terminals for maintained third party contract closure inputs.
 3. Input max. sink/source current: 1-5 mA
 4. Logic input signal voltage High: Greater than 18VDC
 5. Logic input signal voltage Low: Less than 2VDC
 6. Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.
 7. Two RJ-45 ports for connection to DLM local network.
 8. Wattstopper part number: LMIN-104
- C. Provide a single pole switch for control on the contact closure interface.
- D. Provide partition controls as shown on the drawings.

2.13 FOUR POLE CONTACTOR WITH ENCLOSURE

- A. The Multi-Pole Contactor is a compact, electrically held lighting contactor used for controlling lighting and other electrical loads. The multi-pole contactor is available in 4 poles, normally open, 115V or 277V coil voltage and compact DIN rail clip.
- B. The enclosure is a surface-mount NEMA 1 rated enclosure with a DIN rail for mounting equipment and a removable cover. The conduit entrances and enclosure sections for high voltage (Class 1) and low voltage (Class 2) wiring are completely separated.
- C. WattStopper Product Numbers:
 1. Enclosure: LS-E8 or LS-E12
 2. Contactor: C115NO or C277NO
 3. Room Controller: LMRC-111.
- D. Provide four pole contactor with enclosure and room controller for control as shown on the Drawings.

2.14 EXTERIOR DAYLIGHT SENSORS

- A. Calibrated with independent turn-on and turn-off thresholds; minimum 2 foot-candles difference between the turn-on and turn-off thresholds.
- B. Enclosed in weatherproof housing with shading and lens protection visor.
- C. Wattstopper Model LMIN-104 with LMPO-200.
- D. Provide one exterior daylight sensor located on an exterior wall facing north.

2.15 DLM LOCAL NETWORK (Room Network)

- A. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.
- B. Features of the DLM local network include:
 - 1. Plug n' Go® automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 - 2. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration, or setup.
 - 3. Push n' Learn® configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 - 4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30' from a sensor, wall switch or IR receiver.
- C. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
- D. If manufacturer's pre-terminated Cat 5e cables are not used for the installation, the contractor is responsible for testing each cable following installation and supplying manufacturer with test results.
- E. WattStopper Product Number: LMRJ-PXX, LMRJ-C8, LMRJ-S8, LMRJ-CS8.
- F. Provide quantities as required.

2.16 DLM SEGMENT NETWORK (Room to Room Network)

- A. DLM shall allow for three separate types of Room-to-Room ("Segment") communication so that information may be shared between them and any front-end hardware. The system shall allow either Wired, Wireless, or both Wired and Wireless (Hybrid) Room-to-Room Segment Networks communication types to be used.

- B. For a wired Segment Network, provide a linear topology, BACnet-based MS/TP conductor to connect DLM local IRB networks (rooms) and LMCP relay panels to allow for centralized control.
 - 1. Each connected DLM local room network shall include a single network bridge (LMBC-300). The network bridge is the only room-based device that is connected to the segment network.
 - 2. Network bridges, relay panels or network controllers with integral network bridges, shall include a terminal block with provisions for separate "in" and "out" terminations, for Wired segment network wire connections.
 - 3. Wired segment network utilizes 1.5 twisted pair, shielded, cable ordered from the lighting control manufacturer. Maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.
 - 4. Network wire jacket for interior applications is available in high visibility green, white, or black. A black version for direct burial is also available.
 - 5. Substitution of manufacturer-supplied cable is not permitted and may void the warranty if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
 - 6. Network signal integrity requires that each conductor, ground wire and shield be correctly prepared and terminated at every connected device. Use of crimp on ferrules are highly recommended for each individual wire termination.
- C. WattStopper Product Numbers: LM-MSTP, LM-MSTP-W, LM-MSTP-B, LM-MSTP-DB
- D. Provide quantities as required.

2.17 HANDHELD CONFIGURATIONS TOOLS

- A. Provide handheld configuration tool to facilitate customization of Wired DLM devices using two-way infrared communications. Can be used with or without PC software that connects to each local network via a USB interface.
- B. Features and Functionality of the Handheld Configuration Tool Shall Include:
 - 1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
 - 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
 - 3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify DLM devices by type and serial number.
 - 4. Save up to eight occupancy sensor setting profiles and apply profiles to selected sensors in same room or other rooms.
 - 5. Adjust current light level of any load(s) on the local network and capture those levels in scene setting. If fixtures with DLM tunable white Blanco devices are present in room, handheld can also adjust their CCT level.
 - 6. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings, enable or disable load shed status, and identify all IRB connected devices by their part number, and hardware/firmware versions.

7. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
8. Verify status of Bridge Devices connected to Wired or Wireless Segment networks.

C. WattStopper Product Number: LMCT-100-2

D. Provide one handheld configuration tool for the building.

2.18 WIRED NETWORK BRIDGES

- A. Network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a front end network controller or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. Network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.
 1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
 2. Provide Plug n Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the Network Controller via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
 3. Network bridge shall support digital communications to facilitate the control of all devices in its local Cat 5e network to provide interoperability with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet protocol.
 - a. Bridge shall have provision for an individual BACnet device ID and shall support the full 2^{22} range (0 - 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
 - b. Bridge shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
 - c. Setup and commissioning of panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote.
 - d. Description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
 - e. BO and BV 1 - 99 objects shall support BACnet priority array with a relinquish default of off and afterhours, respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (<http://www.bacnet.org/Addenda/Add-135-2010aa.pdf>).
 4. Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical

MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:

- a. Read/write the normal or after hours schedule state for the room.
- b. Read the detection state of each occupancy sensor.
- c. Read the aggregate occupancy state of the room.
- d. Read/write the On/Off state of loads.
- e. Read/write the dimmed light level of loads.
- f. Read the button states of switches.
- g. Read total current in amps, and total power in watts through the load controller.
- h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings.
- i. Activate a preset scene for the room.
- j. Read/write daylight sensor fade time and day and night setpoints.
- k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells.
- l. Set daylight sensor operating mode.
- m. Read/write wall switch lock status.
- n. Read watts per square foot for the entire controlled room.
- o. Write maximum light level per load for demand response mode.
- p. Read/write activation of demand response mode for the room.
- q. Activate/restore demand response mode for the room.

- B. WattStopper product numbers: LMBC-300
- C. Provide a wired network bridge with every room controller.

2.19 NETWORK ENCLOSURE WITH SEGMENT MANAGER, ROUTER, SWITCHES & MODEM

- A. For networked applications, the Digital Lighting Management system can include one or more Front End Network Controllers with Segment Manager Interface (referred to as a Network Controller below) to manage network communication. It shall be capable of serving up a user interface to a standard web browser.
- B. Each Network Controller shall have integral support for two wired MS/TP segment networks. Segment networks may alternately be connected to the Network Controller via external BACnet/IP interface routers or Wireless Border Routers and Network switches using Ethernet structured wiring. Each router shall accommodate one "segment" - respectively a wired MS/TP run or Wireless Mesh Segment Network. Provide the quantity of routers and switches as shown on the Drawings.
- C. Operational features of the Network Controller shall include the following:
 1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
 2. Easy to use graphical user interface, compatible with current Chrome or equivalent browser. The Network Controller shall not require installation of any lighting control software on an end-user PC, but if Manufacturer's Lighting Control Software is installed, it shall be able to work in tandem with the Network Controller without issue.
 3. Log in security capable of restricting some users to view-only or other limited operations.

4. Network Controller with N4 operating systems shall include two main sets of interface screens - those used to initially configure the unit (referred to as the config screens), and a those used to allow users to dynamic monitor the performance of their system and provide a centralized scheduling interface. Capabilities using the Config Screens shall include:
 - a. Automatic discovery of DLM devices and relay panels on the segment network(s). Discovery function shall provide communication, monitoring or control of all local devices and lighting control panels.
 - b. Allow information for all discovered DLM devices to be imported into the Network Controller via a single XML based site file from the Wattstopper LMCS Software, reducing the time needed to make a system usable by the end user. Importable information can include text descriptions of every DLM component and individual loads, and automatic creation of room location information and overall structure of DLM network. Info entered in LMCS should not have to be re-entered manually via keystrokes into the Network Controller
 - c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. User selection of a device in the tree will allow its settings and operational parameters to be viewed and changed.
 - d. Ability to view and modify DLM device operational parameters. It shall be possible to set device parameters independently for normal hours and after-hours operation including sensor time delays and sensitivities, and load response to sensor of Manual-On or Auto-On.
 - e. Provide capabilities for integration with a BAS via BACnet protocol. Depending on project hardware, previously mentioned BACnet points shall be available to the BAS via BACnet/IP connection to the Network Controller: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug load power; load dimming level. BACnet items shall be capable of being moved into an "Export Table" that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator's request for info and the overall system performance.
 5. Capabilities using the Network Controller with N4 operating system's Dashboard Screens shall include:
 - a. Ability to set up schedules for DLM local networks (rooms) and panels. Schedules shall be capable of controlling individual rooms or groups of loads with either on/off or normal hours/afterhours commands. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as Astro On or Astro Off events with offsets. Schedules shall be viable graphically as time bars in a screen set up to automatically show scheduled events by day, week, or month.
 - b. For fixtures that have CCT capability as specified under paragraph "Digital Wall Switch and Timer For Correlated Color Temperature", the Network Controller will provide schedule functionality similar to the CCT Wall Timer.
- D. Segment Manager shall support multiple DLM rooms as follows:
1. Support up to 125 network bridges and 2000 digital in-room devices. (LMJA-8125-SM).
 2. Support up to 300 network bridges and 2000 digital in-room devices, connected via network routers and switches (LMJA-8300-SM).

- E. 4G LTE modem, 1st year cellular service data plan, external antenna, and 1st year enhanced warranty for use with Segment Manager LMJA system (RACCESS-3 or RACCESS-6).
- F. Routers and switches
 - 1. Routers and switches sized for the project. (NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16)
- G. DLM Network Component Enclosure
 - 1. Network component enclosure with power supply sized for equipment needed. (LMNC-X)
- H. Provide DLM network component enclosure with segment manager, router, switches and 4G LTE modem sized appropriately for the project.

2.20 NETWORK SWITCH WITH ENCLOSURE

- A. The Network Switches are enterprise-grade Ethernet switches that work with up to four or seven NB-ROUTERS to provide high speed connectivity for Digital Lighting Management (DLM) networked systems. The compact switch has a rugged metal enclosure and integral DIN rail clip.
- B. The Enclosure is a surface-mount NEMA1 rated enclosure with a DIN rail for mounting equipment and a removable cover. The conduit entrances and enclosure sections for high voltage (Class 1) and low voltage (Class 2) wiring are completely separated.
- C. WattStopper Product Numbers: LMNC-ENCC1 with NB-SWITCH, NB-SWITCH-8, or NB-SWITCH-16.
- D. Provide DLM Global Network 5-Port, 8-Port, or 16-Port Ethernet Switch in NEMA 1 small enclosure when the distance between a border router and LMJA is greater than 300 feet.

2.21 PROGRAMMING, CONFIGURATION, AND DOCUMENTATION SOFTWARE

- A. PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or all products over a wired or wireless segment network utilizing standard BACnet/IP communication.
- B. Additional parameters exposed through this method include but are not limited to:
 - 1. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
 - 2. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.
 - 3. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.

4. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
 5. Separate normal hours and after hours per-load button mode with modes including Do nothing, on only, off only, on and off.
 6. Load control polarity reversal so that on events turn loads off and vice versa.
 7. Per-load DR (demand response) shed level in units of percent.
 8. Load output pulse mode in 254 steps either 0.1 seconds or 1 second.
 9. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.
- C. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
1. Device list report: All devices in a project listed by type.
 2. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
 3. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
 4. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.
 5. Device parameter report: Per-room lists of all configured parameters accessible via handheld IR programmer for use with O and M documentation.
 6. Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100 percent, 2 = all loads 75 percent, 3 = all loads 50 percent, 4 = all loads 25 percent, 5-16 = same as scene 1).
 7. Occupancy sensor report: Basic settings including time delay and sensitivities for all occupancy sensors.
- D. Network-wide programming of parameter data in a spreadsheet-like Network Grid programming environment including but not limited to the following operations:
1. Set, copy/paste an entire project site of sensor time delays.
 2. Set, copy/paste an entire project site of sensor sensitivity settings.
 3. Search based on room name and text labels.
 4. Filter by product type (i.e. LMRC-212) to allow parameter set by product.
 5. Filter by parameter value to search for product with specific configurations.
- E. Network-wide firmware upgrading remotely via the BACnet/IP network.
1. Mass firmware update of entire rooms.
 2. Mass firmware update of specifically selected rooms or areas.
 3. Mass firmware upgrade of specific products
- F. WattStopper Product Numbers: LMCS-100, LMCI-100
- G. Provide design and programming of software for the project.

2.22 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. WattStopper Product Numbers: ELCU-100, ELCU-200.
- C. Provide quantities as required.

2.23 PRE-TERMINATED PATCH CABLES

- A. Provide pre-terminated plenum rated patch cables as required for the project.
- B. WattStopper Product Number: LMRJ-PXX
- C. Provide quantities as required.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION MEETING

- A. WattStopper Product Number: PRESTARTUP / FASTARTUP
- B. The Contractor is responsible to arrange a pre-installation meeting with manufacturer's factory authorized representative, electrical contractor and building owner representatives.
- C. 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.
- D. 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.
 - 5. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
 - 6. Review the specifications for low voltage control wiring and termination.
 - 7. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.

- E. Inspect and make notes of job conditions prior to installation:
 - 1. Record minutes of the conference and provide copies to all parties present.
 - 2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.
 - 3. Installation shall not begin until all outstanding issues are resolved to the satisfaction of the Architect.

3.2 INSTALLATION

- A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.
- B. Install all room/area devices using manufacturer's factory-tested Category 5e cable with pre-terminated RJ-45 connectors.
 - 1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
 - 2. Low voltage wiring topology must comply with manufacturer's specifications.
 - 3. All Category cabling shall comply with Section 271500 or 271501 requirements.
 - 4. Document final wiring location, routing, and topology on as built drawings.
- C. 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. Following manufacturer's recommendations, calibrate, 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. Sequence of Operation, (e.g., Auto On, Partial ON, Partial Off, etc.)
 - 2. Load parameters (e.g., blink warning, group integrations, etc.)
 - 3. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
- 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 Class 1 conductors at circuit breaker and termination point to torque ratings marked on enclosure or device's UL label or installation instructions.
- J. Class 2 cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class 1 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 neutrals and should not be mixed within any individual room controller or multiple 0-10V input phase converters.
- 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. WattStopper Product Number: SCOM
- B. Provide manufacturers factory-trained technician to verify that all system hardware is installed and configured in accordance with the project requirements. These services test and verify the systems are operating as intended, implement a sequence of operations, and provide a basic starting program configuration.

3.4 POST STARTUP ADJUSTMENTS

- A. WattStopper Product Number: POSTSTARTUP / FAPOSTSTARTUP
- B. Provide a scheduled visit within the warranty period for commissioning assistance, system optimization, and troubleshooting.

3.5 TRAINING

- A. WattStopper Product Number: STRAIN / FATRAINING
- B. Personnel Training: Provide and pay for the services of a factory-authorized service representative to demonstrate the system and train Owners' personnel.
 - 1. Provide training for operating, testing, troubleshooting and general maintenance of the system.
 - 2. Manufacturer shall include training required for the equipment provided.
 - 3. Provide documentation of sessions to Architect/Engineer with signatures of at least 3 Owners Representatives present at demonstration.

END OF SECTION 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 262300 – MINI-POWER ZONES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Mini-Power Zones

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code
- B. NEMA PB 1 – Panelboards
- C. NEMA PB 1.1 – Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
- D. NEMA AB 1 – Molded Case Circuit Breakers
- 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. Federal Specification W-P-115C – Type 1, Class 1
- K. Federal Specification W-C-375B/Gen – Circuit Breakers, Molded Case, Branch Circuit, and Service
- L. ASTM – American Society of Testing Materials
- M. NEMA ST 20 - Dry Type Transformers for General Applications
- N. NETA-ATS - Acceptance Testing Specification for Electrical Power Distribution Equipment (International Electrical Testing Association)
- O. 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 primary voltage, primary main breaker, phase, secondary voltage, secondary main breaker, short circuit rating and circuit breakers with specific items or model numbers highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Record actual locations of mini-power zones in project record documents.
- C. 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.
- D. Provide a copy of approved Panel Directory Schedules to be included in O&M Manuals.

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 mini-power zones individually wrapped for protection and mounted on shipping skids.
- C. Accept mini-power zones on site and 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.

1.8 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

2.2 MINI-POWER ZONE – GENERAL

- A. A mini-power zone combines three individual components into one NEMA Type 3R enclosure:
 - 1. A primary main circuit breaker
 - 2. An encapsulated single-phase or three-phase dry-type transformer
 - 3. A secondary distribution panelboard with main breaker.
- B. Interconnecting wiring is completed at the factory.
- C. Enclosure shall be cleaned, phosphatized and electrostatically powder coated with ASA 49 color.
- D. Package power supplies shall include integrally mounted and wired primary and secondary main circuit breakers in accordance with National Electric Code requirements.
- E. A hinged access door shall be provided which maintains itself in the Open position when desired, and which has padlock provisions to prevent unauthorized entry.
- F. All live parts are to be fully enclosed for personal protection when installation is completed.
- G. The transformer and panelboard shall be a solid unit that cannot be assembled or disassembled.
- H. All sizes sound shall be UL listed for use as service equipment.

2.3 PRIMARY BREAKER

- A. 480 Volt primary main breaker.
- B. Available AIC:
 - 1. 18,000 AIC
 - 2. 25,000 AIC
 - 3. 65,000 AIC
- C. Main circuit breakers shall have an overcenter, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.

- 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.

2.4 TRANSFORMERS

- A. Single phase transformer shall be 480 Volt primary and 120/240 Volt secondary.
 - 1. Available sizes: 3,5,7.5,10,15 or 25
- B. Three phase Transformers shall be 480 Volt primary and 208Y/120 Volt secondary.
 - 1. Available sizes: 15,22.5 or 30
- C. All Transformers should have a minimum of 2-5% full capacity primary tabs below normal and shall be rated 115°C temperature rise above 40°C maximum ambient.
- D. All insulating materials are to be in accordance with current ANSI C 89.2 and NEMA ST20 standards for a 185°C UL component recognized insulation system.
- E. Transformers are to be encapsulated using a sand epoxy resin mixture to provide maximum protection against moisture, dust, and corrosive environments.

2.5 PANELBOARD

- A. Panelboards: NEMA PB1, circuit breaker type.
- B. Interior:
 - 1. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard.
 - 2. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
 - 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 aluminum 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. Main Circuit Breaker:
 - 1. Main circuit breakers shall have an overcenter, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.
 - 2. 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.

D. Branch Circuit Breakers:

1. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the associated panel schedules.
2. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with a common trip handle for each pole.
3. Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
4. Provide circuit breakers UL listed as Type SWD for lighting circuits.
5. Provide circuit breakers UL listed as Type HACR for heating, air conditioning and refrigeration equipment branch circuits.
6. 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.
7. There shall be two forms of visible trip indication.
8. The exposed faceplates of all branch circuit breakers shall be flush with one another.
9. Lugs shall be UL Listed to accept solid or stranded conductors.

2.6 ENCLOSURE

- A. Type 3R: Powder coat painted, standard hot-rolled steel.
- B. Type SS304: Powder coat painted, 304 stainless steel.
- C. Type SS316: Powder coat painted, 316 stainless steel.

2.7 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 EXAMINATION

- A. Verify that surfaces are suitable for installing transformer supports.

3.2 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1 and NEC Standards.
- B. Provide supports in accordance with Section 260529.
- C. Refer to Section 260010 for mounting heights.

- D. Provide breaker closures for unused spaces in panelboards.
- E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads. See also Paragraph 1.4.C.
- F. 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.
- G. Ground and bond panelboard enclosure in accordance with Section 260526.

END OF SECTION 262300

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 2 – 100% neutral assemblies in all split bus panelboards.

- I. Provide “Hinged Trim” panelboard covers for all distribution and branch circuit panelboards. The entire trim shall be hinged to swing to one side of the box to access the panel gutter space.
- J. All Panelboards with greater than 42 poles shall have 2 panel backboxes. Single backboxes with more than 42 poles will be unacceptable.
- K. Provide manufacture start-up and training when required for the equipment provided.

2.3 PANELBOARD SHORT CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
- B. Fully rated to interrupt symmetrical short-circuit current available at terminals.
- C. Manufacturers option unless noted otherwise on the Panel Schedules or Power Riser Diagram.

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 PM5560
 - b. Eaton Model PXE-1/PXM1K – ETHMULTI-NW Series
 - c. Siemens Model 9410E Series
 2. Digital Power Meter with 0.25% accuracy with the following features: A, V, kW, kVAR, kVA, PF, F kWh, kVARh, kVAh, KYZ, RS-485 Communications, Ethernet Communications

- THD, Demand, kWd kVARd, kVAd, date/time stamping, predicted power demand, onboard alarms, min/max readings, data log, and event log.
 - a. Onboard WEB pages to view real-time and logged information.
 - b. Connection point for Energy Management System.
- 3. Circuit Monitor Installation:
 - a. Electronic Circuit Monitors shall be installed by the panelboard manufacturer for all circuits as indicated by the project drawings. Mount no lower than 48" and no higher than 72".
 - b. All control power, CT, PT, and communications wire shall be factory wired and harnessed within the panelboard.
 - c. Where external circuit connections are required, terminal blocks shall be provided, and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.
- 4. Certification Description:
 - a. All equipment included as part of the power and trip history metering shall be UL listed.
 - 1) IEC 62053-23
 - 2) IEC 62052-11
- B. Provide necessary hardware to support monitoring of real-time operational data from trip units and customer meters in Panelboards.
 - 1. Hardware shall support protocol conversion from Modbus →BACNET/IP to support monitoring of data by customer BMS System.
 - 2. Hardware shall have the capability to monitor a minimum of 50 parameters from each installed trip unit via Modbus protocol and mapping these points to a common register map compatible with BACNET/IP protocol.
 - 3. Hardware shall have the capability to monitor a minimum of 20 Modbus devices concurrently.
 - 4. Hardware should be as manufactured by Sierra Montiro Protonode or approved equal.
- C. Provide Manufacturers Field Service to start-up, set-up, and train the Owner for all meters.

2.8 INTEGRATED SURGE SUPPRESSION DEVICE

- A. Provide integrated surge suppression device when indicated on the Panel Schedule or Power Riser Diagram.
- B. Integral Surge Suppressor:
 - 1. SPD shall be component recognized in accordance with UL 1449 Fourth Edition. SPD shall be installed by and shipped from the electrical distribution equipment manufacturer's factory.
 - 2. The surge protection devices shall be bus mounted. If a breaker is needed to feed the integrally mounted SPDs, provide the breaker and wiring required.
 - 3. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G in WYE Systems.
 - 4. SPD shall be constructed as a per phase or single system module design. Each mode including N-G shall be protected by internal overcurrent and thermal overtemperature controls.

5. SPD shall be UL 1449 listed and labeled with 200kA Short Circuit Current Rating (SCCR).
6. SPDs shall be equipped with the following diagnostics:
 - 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 TVS41MA12
 - b. Eaton Model SPD120480Y2A
 - c. Siemens Model TPS3E0515X2, TPS3E0115X002, TPS3E0115X2
- F. Internal Type L1 Unit: Non-Critical Load Applications:
1. Voltage Rating: 208Y/120V, 3-phase, 4-wire
 2. Application: Distribution Panelboard
 3. Minimum Modes of Protection: Common or Normal: L-N, L-G, N-G
 4. Maximum UL 1449 Voltage Protection Ratings (VPRs) for L-N, L-G, and N-G Modes of Protection: 700 volts.
 5. I-nominal Rating: 20kA
 6. Minimum Acceptable Single Pulse Surge Current Capacity: 240,000 amps per phase
 7. The following Models are acceptable:
 - a. Square D Company Model TVS21MA24
 - 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 TVS21MA16
 - 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 TVS21MA12
 - b. Eaton Model SPD120208Y2A
 - c. Siemens Model TPS3C0515X2, TPS3C0115X002, TPS3C0215X2

2.9 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 contractor 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.

2.10 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 typed circuit directory for each branch circuit panelboard.
 - 1. Revise directory to reflect circuiting changes required to balance phase loads.
 - 2. Contractor to submit a copy of all panelboard directory schedules to the Owner, showing correct room name and/or number, for his approval. Contractor to make changes recommended by the Owner before final typed directories are installed in panelboards.
- H. Provide engraved plastic nameplates for each panelboard with 1/2" high lettering. Label shall include the following:

1. Panel Name
 2. Voltage, Phase, Wire
 3. Location of the panel, switchboard or disconnect device which feeds the panelboard.
- I. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Minimum spare conduits: 1 empty 1" per 4 poles of spare breakers and spaces. Identify each as SPARE.
 - J. Provide accessories which prevent circuit breaker handles from being manually moved from the ON position for the handles of all circuit breaker which feed emergency lighting circuits, public address and intercom systems and uninterruptable power supplies.
 - K. Ground and bond panelboard enclosure in accordance with Section 260526.
 - L. Provide category 6 cable in 3/4" conduit from each meter to nearest MDF/IDF and terminate on both ends unless otherwise noted.
 - M. Provide a dedicated 3-pole branch circuit breaker to feed TVSS unit (only when required by manufacturer). Circuit breaker size and wire size shall be per manufacturer recommendation. Connect leads to load side of the circuit breaker.
 - N. Where replacing existing panels and existing conductors are to be connected to new CB's, provide extensions of conductors as needed using same color and size of wire using a butt-splice.
 - O. Contractor shall trace all circuits listed as "Existing Circuits" and provide the correct description for the circuit. Existing Circuit will not be acceptable in the Final Panel Schedules.
 - P. Provide main lug only and main breaker lugs that are sized to terminate the conductors shown on the plans. Where lug sizes are not available to terminate the scheduled conductors the Electrical Contractor (EC) shall provide compression reducing pin terminals that are rated for the application. Where termination lug quantities are not available for the equipment the EC shall provide insulated termination lug sets with the quantity of conductors as needed to connect to the equipment. Conductor lengths shall be kept to a minimum and sized to meet the largest lug size and quantity available on the equipment. In no case shall the conductors be sized less than the amp rating of the circuit breaker feeding the equipment. All parallel sets of raceways, junction boxes and associated accessories shall be included.

3.2 FIELD QUALITY CONTROL

- A. Perform field inspection and testing.
- B. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections.
- C. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 10% of each other. Maintain proper phasing for multi-wire branch circuits.

- 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 off):
1. Hubbell Model HBL1221XL
 2. Leviton Model 1221-LHI or 1221-7LX
 3. Pass & Seymour Model PS20AC1-XSL
 4. Provide 2-pole, 3-way and 4-way switches of the same series as required.
- D. Indicator Switch: 1P, 120/277V, 20A (Light on with load on):
1. Hubbell Model HBL1221PL
 2. Leviton Model 1221-PLI or 1221-7PX
 3. Pass & Seymour Model PS20AC1-XPL or PS20AC1-RPL7
 4. Provide 2-pole, 3-way and 4-way switches of the same series as required.
- E. Single Button Automatic Wall Switch: 120/277V, 20A:
1. Watt Stopper Model DW-100
 2. Sensor Switch Model WSX-PDT-XX
 3. Leviton Model OSSMT-MDX
 4. Lutron Model MSX102-XX
- F. Two Button Automatic Wall Switch: 120/277V, 20A:
1. Watt Stopper Model DW-200
 2. Sensor Switch Model WSX-PDT-2P-XX
 3. Leviton Model OSSMD-MDX
 4. Lutron Model MSX202-XX
- G. 0-10V Dimming Wall Switch Occupancy Sensor: 120/277V, 20A:
1. Watt Stopper Model DW-311-X
 2. Hubbell Model LHDMMTS-2-N-XX
 3. Sensor Switch Model WSX-PDT-D-XX
- H. Digital Time Switch: 120/277V, 20A:
1. Watt Stopper Model TS-400
 2. Sensor Switch Model PTS-60
- I. Explosion Proof Single Pole Switch: 120/277, 20A:
1. Appleton Model EFS175-F1 or EFSC175-F1.
 2. Provide 2-pole, 3-way and 4-way switches of the same series as required.
- J. Color: Ivory unless directed otherwise by Architect.

2.2 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 TR20USBC6X
 - 3. Engineer's Choice on USB Type.
- E. Tamper-Resistant/Weather-Resistant GFCI Receptacle with USB Charger: 125V, 20A:
 - 1. Hubbell Model GFUSBWR20ACX
 - 2. Pass & Seymour Model TR20USBAC6CDW.
 - 3. Engineer's choice on USB type.
 - 4. All GFI Receptacles shall meet the latest Standard 943 for Class A GFI Receptacles/UL 498 for receptacle.
 - 5. 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 Convenience Receptacle: 125V, 20A:

1. Hubbell Model HBL5361X
2. Leviton Model 5361-X
3. Pass & Seymour Model 5361-X
4. Provide isolated ground and hospital grade type of the same series where indicated on the Drawings.

B. Duplex Convenience Receptacle: 125V, 20A:

1. Hubbell Model HBL5362-X
2. Leviton Model 5362-X
3. Pass & Seymour Model 5362AX
4. Provide isolated ground and hospital grade type of the same series where indicated on the Drawings.

C. GFCI Receptacle: 125V, 20A:

1. Hubbell Model GFR20X
2. Leviton Model GFNT2-X
3. Pass & Seymour Model 2097X
4. All GFI Receptacles shall meet the latest Standard 943 for Class A GFI Receptacles/UL 498 for receptacle.
5. Provide isolated ground and hospital grade type of the same series where indicated on the Drawings.

D. Surge Suppressor Receptacle: 125V, 20A:

1. Hubbell Model HBL5360XSA
2. Leviton Model 5380-X
3. Pass & Seymour Model 5362XSP
4. Provide isolated ground and hospital grade type of the same series where indicated on the Drawings.

E. USB Charger Receptacle: 125V:

1. Hubbell Model USB4ACX or USB4CX
2. Pass & Seymour Model TM8USB4XCC6
3. Engineer's Choice

F. 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.

G. Explosion Proof Receptacles: 125V, 20A:

1. Hubbell UGRO20231 or UGRA20231
2. Appleton Model CPE2-2375 or CPC2-2375

H. 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.)

I. 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.)

J. 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. Super Stainless-Steel Receptacle Cover Plate: Interior Finish Walls:

1. Hubbell Model SS8/SS26

2. Leviton Model 84003/84401-40
 3. Pass & Seymour Model SS8/SS26
- B. Super Stainless-Steel Switch Cover Plate: Interior Finish Walls:
1. Hubbell Model SS1
 2. Leviton Model 84001
 3. Pass & Seymour Model SS1
- C. Metal Receptacle Cover Plate: Electrical Rooms, Mechanical Rooms and Boiler Rooms:
1. Cooper Crouse-Hinds Model TP516
 2. Appleton Model 8365N
 3. Steel City Model RS12
- D. Metal Switch Cover Plate: Electrical Rooms, Mechanical Rooms, and Boiler Rooms:
1. Cooper Crouse-Hinds Model TP512
 2. Appleton Model 8361
 3. Steel City Model RS-9
- E. Weatherproof While In Use Cover: All exterior building mounted receptacles unless otherwise noted.
1. Hubbell Model WP26E
 2. Leviton Model 5977-CL
 3. Pass & Seymour Model WIUC10-XX
 4. Taymac Model MX3200
 5. Rating shall be maintained while in use.
 6. Provide horizontal cover if receptacle is mounted horizontally.
- F. Provide all additional combination cover plates of the same series required for the entire project. All devices in the project shall have a cover plate.
- G. Provide all devices, outlet boxes, junction boxes, etc with the appropriate type cover plate.
- H. Provide junior or jumbo size plates as required of the same series and type for all outlets installed in masonry walls.
- I. Wiring devices connected to Normal/Emergency power shall be red in color and pre-marked "Emergency" unless otherwise indicated on the Drawings or by the Architect.

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.

3.8 SETUP

- A. Provide dip switch setting for the following setup:
 - 1. Single Button Automatic wall switch:
 - a. On – Manual
 - b. Off – Sensor (15-minute delay)
 - 2. Two button automatic wall switch:
 - a. On – Manual
 - b. Off – Sensor (15-minute delay)
 - 3. 0-10V dimming wall switch occupancy sensor:
 - a. On – Manual
 - b. Off – Sensor (15-minute delay)

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, RFBA6C30OG, RFBA4C30OG, OR RFBA2C30OG (epoxy coated); RFBA10C55, RFBA6C30, RFBA4C30 or RFBA2C30 (stamped steel) with (1) XCTC2NK cover, duplex mounting plates, data mounting plates and all required components for a complete installation.
 - b. Hubbell Model CFB10G55RCRE, CFB6G30RCRE, CFB4G30RCRE, or CFB2G30RCRE (epoxy coated); CFB10G55RE, CFB6G30RE, CFB4G30RE, or CFB2G30RE (stamped steel) with (1) CFBS1RXCVRNKL cover, duplex mounting plates, data mounting plates and all required components for a complete installation.
 - c. Provide all necessary power and telecommunication fittings required for a complete installation.
 - d. Provide conduits as required for components shown and a spare 1-1/4" conduit to accessible ceiling cavity for future use.
- B. Floor Box Convenience Receptacle(s) and Telecommunication Outlet(s) and Telecommunication Outlet(s), Wood Floor:
 - 1. Housing: Stamped steel
 - 2. Plate Finish: Aluminum (Verify with Architect)
 - 3. Configuration: Two duplex receptacles and telecommunication outlets unless otherwise indicated.
 - 4. Box and cover shall meet UL 514A Water Exclusion Test
 - 5. Manufacturers:
 - a. Wiremold Model 880WX with Activation Kit as applicable.
 - b. Hubbell Model B2481 with cover as required.
 - c. Provide all necessary power and telecommunication fittings required for a complete installation.
 - d. Provide conduits as required for components shown.

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 (Verify with Architect)
 - 3. Configuration: Receptacles and Telecommunication outlets as indicated on the Drawings.
 - 4. Size: 10", 8", 6", or 4" cored holes and matched to floor thickness.
 - 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, 6AT or 4AT with (1) XCTC2NK cover, duplex mounting plates, data mounting plates and all required components for a complete installation.
 - b. Hubbell Model S1R10PTFIT, S1R8PTFIT, S1R6PTFIT, or S1R4PTFIT 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 (Verify with Architect)
 3. Telecommunication Configuration – 1 – 3/4" liquid tight conduit from floorbox 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 S1R4PTAVFIT with 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 floorboxes or poke-thru's with furniture provided by General Contractor or Owner before roughing-in (verify)
- 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. Littlefuse, Inc.
- C. Mersen

2.2 FUSE REQUIREMENTS

- A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
- B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
- C. All fuses in the power distribution system shall be by the same manufacturer.
- D. Main Service Switches Larger than 600 amperes: Current Limiting Class L (time delay).
- E. Motor Load Feeder Switches: Current Limiting Class RK1 (time delay).
- F. Motor Branch Circuits: Class RK5. (time delay).
- G. Parallel service and feeder cables - cable limiters.

2.3 SPARE FUSE CABINET

- A. Description: Wall-mounted sheet metal cabinet, suitably sized to store spare fuses and fuse pullers specified.
- B. Doors: Hinged, with hasp for Owner's padlock.
- C. Finish: Primed and painted medium gray.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in accordance with manufacturer's instructions.
- B. Install fuse with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet where directed by Owner.
- D. Provide an adhesive label inside each enclosure or compartment indicating the size and type of replacement fuse to be installed. Where multiple sizes or types of fuses are installed in a single enclosure placement or coding of labels shall clearly indicate the fuses to which the labels refer.
- E. Install cable limiters on both ends of each parallel cable in the designated set.

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 262830 – ENCLOSED CONTACTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electrically held lighting contactors
- B. Mechanically and magnetically held lighting contactors

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code
- B. NEMA ICS 2 – Controllers, Contactors and Overload Relays.
- C. NEMA ICS 5 – Control Circuit and Pilot Devices.
- D. NEMA ICS 6 – Enclosures for Industrial Controls and Systems.
- E. UL 508, Industrial Control Equipment.

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 ratings, current ratings, dimensions and enclosure with the specific item or model number highlighted.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.
- B. Maintenance Data: Include spare parts data, instructions for replacing and maintaining coil and contacts, 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. 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 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 ELECTRICALLY HELD LIGHTING CONTACTORS

- A. Manufacturers:
 - 1. Square D Company
 - 2. Eaton
 - 3. Siemens
- B. Description: NEMA ICS 2 electrically held magnetic lighting contactor with continuously rated coils. Contactors shall be rated for all standard type ballast and tungsten lighting as well as general use and resistive heating loads.
- C. Contactor Ampere Rating: As scheduled or indicated.
- D. Poles: As scheduled or indicated.
- E. Power Contacts: To be totally enclosed in contactor housing and have double break operation.
- F. Coil operating voltage: 120 volts, 60Hz unless otherwise indicated.
- G. Wiring: Straight-through wiring with all terminals clearly marked.
- H. Enclosure: NEMA ICS 6, Type:
 - 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
- I. Accessories: As indicated or required.
 - 1. Pilot Devices: NEMA ICS 5, cover-mounted type or flange-mounted 30mm type based upon enclosure selection. Contacts shall be rated NEMA B600 for cover-mounted devices and NEMA A600 for flange-mounted 30mm devices.
 - a. Pushbutton: On – Off
 - b. Selector Switch: Off/On

- c. Indicating Light(s): Red On, and Green Off
- 2. Control Power Transformers: As scheduled.
 - a. Provide fused primary and secondary and connect non-fused leg of secondary to enclosure.

2.2 MECHANICALLY AND MAGNETICALLY HELD LIGHTING CONTACTORS

- A. Manufacturers:
 - 1. Square D Company
 - 2. Eaton
 - 3. Siemens
- B. Description: NEMA ICS 2 mechanically held lighting contactor which is electrically operated. Standard coil clearing contacts are to be provided so that the contactor coils shall be energized only during the instance of operation. Contactors shall be rated for all standard type ballast and tungsten lighting as well as general use and resistive heating loads.
- C. Contactor Ampere Rating: As scheduled or indicated.
- D. Poles: As scheduled or indicated.
- E. Power Contacts: To be totally enclosed in contactor housing and have double break operation.
- F. Coil operating voltage: 120 volts, 60Hz unless otherwise indicated.
- G. Enclosure: NEMA ICS 6, Type:
 - 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
- H. Accessories: As indicated or required.
 - 1. Pilot Devices: NEMA ICS 5, cover-mounted type or flange-mounted 30mm type based upon enclosure selection. Contacts shall be rated NEMA B600 for cover-mounted devices and NEMA A600 for flange-mounted 30mm devices.
 - a. Pushbutton: On – Off
 - b. Selector Switch: Off/On
 - c. Indicating Light(s): Red On, and Green Off
 - 2. Control Power Transformers: as scheduled.
 - a. Provide fused primary and secondary and connect non-fused leg of secondary to enclosure.
 - 3. Control Modules:
 - a. 2 Wire Control
 - b. 3 Wire Control
 - c. On/Off Control

2.3 IDENTIFICATION

- A. Contactor 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 enclosed contactors where indicated, in accordance with manufacturer's instructions.
- B. Clean interiors of all enclosed electrical equipment to remove construction debris, dirt, and shipping materials.
- C. Repaint scratched or marred exterior surfaces to match original finish.
- D. Install enclosed contactors plumb. Provide supports in accordance with Section 260529.
- E. Refer to Section 260010 for mounting heights.
- F. Provide engraved plastic nameplates for each contactor. Label shall include the following:
 - 1. Contactor Name
 - 2. Voltage
 - 3. Coil Circuit

3.2 TESTING

- A. Perform factory and installation tests in accordance with applicable NEC, NEMA and UL requirements.

END OF SECTION 262830

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 263213 – ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
 - 1. Fuel: Diesel
 - 2. Location: Outdoor

1.2 RELATED WORK/DIVISIONS

- A. Division 23

1.3 REFERENCES

- A. NEMA AB1 - Molded Case Circuit Breakers
- B. NEMA MG1 - Motors and Generators
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- D. NFPA 30 - Flammable and Combustible Liquids Code
- E. NFPA 70 - National Electrical Code
- F. NFPA 101 - Life Safety Code
- G. NFPA 110 - Emergency and Standby Power Systems

1.4 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. Reference to Specification Section.
 - b. A list of all equipment to be provided and installed.
 - c. Data sheets to indicate size, voltage, rating, current rating, dimensions, exhaust silencer, battery charger, transfer switch enclosure and etc with the specific item or model number highlighted.
 - d. Sketch of exhaust piping and copy of exhaust back pressure calculations.
 - e. Fuel consumption rate curves at various loads.
 - f. Ventilation and combustion air requirements.

- g. Manufacturers certificate that product meets or exceeds specified requirements and test report indicating results of performance testing.
 - C. Generator Sizing Report:
 - 1. Create generator sizing report using computer software developed by the generator manufacturer.
 - 2. Include loads as indicated.
 - 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: Diesel Fuel
- D. Engine Speed: 1800 RPM maximum
- E. Governor: Isochronous or electronic type to maintain engine speed within 0.5% steady state, and 5% no load to full load, with recovery to steady state within 2 seconds following sudden load changes.
- F. Safety Devices: Engine shutdown on low coolant level, high coolant temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.
- G. Engine Starting: DC starting system with positive engagement, number, and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.
- H. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90°F. Manufacturer to confirm coolant heater wattage and voltage.
- I. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110°F. Radiator airflow restriction 0.5" of water (1.25 Pa) maximum.

- J. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gauge, water temperature gauge, and lube oil pressure gauge on engine/generator control panel.
- K. Mounting: Provide unit with suitable spring-type vibration isolators and mount on structural steel base if integral pad type isolation is not provided.

2.4 GENERATOR

- A. Generator: NEMA MG1, 3-phase, 4-pole, reconnectible brushless synchronous generator with brushless exciter.
- B. Rating: As indicated on drawings, at 0.8 power factor, 60 Hz at 1800 rpm.
- C. Insulation Class: H
- D. Temperature Rise: 105°C Stand-by
- E. Enclosure: NEMA MG1, open drip proof
- F. Voltage Regulation: Include generator-mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation $\pm 1\%$ from no load to full load. Include manual controls to adjust voltage droop, voltage level ($\pm 5\%$) and voltage gain.
- G. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or 3-phase fault at approximately 300% of rated current for not more than 10 seconds.

2.5 GENERATOR BREAKERS

- A. Legally Required Loads Breaker
 - 1. Square D – Mission Critical Modeled Case Circuit Breaker:
 - a. NEMA AB 1.
 - b. High levels of selective coordination in an electronic trip circuit breaker.
 - c. Time/Current response adjustments: Long Time Pick-Up, Long Time Delay, Short Time Pick-Up, Short Time Delay, and Instantaneous settings.
 - d. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - e. Mount unit in enclosure to meet NEMA 250, Type 1 requirements.
- B. Optional Standby Systems Loads Breaker:
 - 1. Electronic Trip Circuit Breaker
 - a. NEMA AB 1.
 - b. Time/Current response adjustments: Long Time Pick-Up, Long Time Delay, Short Time Pick-up, Short Time Delay, and Instantaneous settings.
 - c. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.

- d. Mount unit in enclosure to meet NEMA 250, Type 1 requirements.
- C. Critical Loads Breaker:
 - 1. Square D – Mission Critical Modeled Case Circuit Breaker:
 - a. NEMA AB 1.
 - b. High levels of selective coordination in an electronic trip circuit breaker.
 - c. Time/Current response adjustments: Long Time Pick-Up, Long Time Delay, Short Time Pick-up, Short Time Delay, and Instantaneous settings.
 - d. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - e. Mount unit in enclosure to meet NEMA 250, Type 1 requirements.
- D. Fire Pump Breaker:
 - 1. Electronic Trip Circuit Breaker
 - a. NEMA AB 1.
 - b. Time/Current response adjustments: Long Time Pick-Up, Long Time Delay, Short Time Pick-up, Short Time Delay, and Instantaneous settings.
 - c. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - d. Mount unit in enclosure to meet NEMA 250, Type 1 requirements.
- E. Provide circuit breakers in the quantity and size of the transfer switches unless otherwise noted.
- F. Provide a permanently fastened pad lockable hasp accessory for each breaker.
- G. Provide a simple coordination study to set up breakers if Section 260573 is not included. If Section 260573 is included, breakers shall be set-up as part of the study.

2.6 ACCESSORIES

- A. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless-steel exhaust fitting, sized in accordance with engine manufacturer's instructions. Electrical Contractor shall provide pipe extension and drip-cup and provide proper type thimble for exhaust pipe protruding thru wall or roof.
- B. Batteries: Heavy duty, diesel starting type lead-acid storage batteries, 170-ampere hours minimum capacity as recommended by the engine manufacturer. Match battery voltage to starting system. Include necessary cables and clamps.
- C. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.
- D. Battery Tray Heater: Provide heater for all exterior generators.
- E. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet NEMA 250, Type 1 requirements.
- F. Remote Emergency Stop Kit for indoor or outdoor generator.

- G. Provide manufacturers standard rodent guards for outdoor generator.

2.7 SKID MOUNTED FUEL TANK

- A. Provide a UL142 compliant, integral, double wall, spill containment, steel tank with usable capacity for 24 hour run at 100% load.
 - 1. Provide secondary containment with leak detection alarm panel.
 - 2. Provide direct reading fuel gauge.
 - 3. Provide five gallon spill fill box.
 - 4. Provide audio/visual fuel level alarm panel.
- B. If the height of the skid mounted fuel tank raises the circuit breakers and control panels above 6'-0", provide an OSHA compliant working platform to access equipment.
 - 1. Provide the OSHA compliant working platform to access all generator equipment with the following items as required for the installation.
 - a. Permanent structure with concrete pad as required.
 - b. Constructed of prefabricated industrial grade aluminum.
 - c. Access stairs.
 - d. Guardrails and handrails.
 - e. Platform to be sized to meet the working clearances of the NEC.
- C. Provide low fuel and rupture basin alarms for tank.
- D. Provide the skid mounted diesel fuel storage tank with an FM Approved and NFPA Equipment Compliant automated Fuel Maintenance System. The system shall be programmable, fully automated, fuel maintenance system that removes water and contaminants wherever fuel is stored or used. System shall remove particulate and separate water from the fuel.
 - 1. Provide the following fuel maintenance system shall be manufactured by Fuel Technologies International (FTI):
 - a. FTI-1.5A – 1,000-gallon tanks.
 - b. FTI-2.8 – 1,000-gallon through 5,000-gallon tanks.
 - c. FT-5A – 5,000-gallon through 15,000-gallon tanks.
 - d. AXI International will be an acceptable equal.
 - 2. Enclosure shall be NEMA 3R rated with a zinc primer with powder coat finish.
 - 3. System Voltage shall be 115V AC, 1 Phase, 60Hz.
 - 4. Provide 24V DC, N.O. leak detector connection point.
 - 5. Provide unit with filters required and 2 spares of each type.
 - 6. Provide the fuel polishing system with a manufacturer's standard 50 watt heater to protect the unit in temperatures below 32 degrees Fahrenheit.
 - a. Heater Voltage shall be 115V AC, 1 Phase, 60Hz.
 - 7. Provide the fuel polishing system with a Modbus RTU RS485 communications card to connect to the building management system.
 - 8. Provide mounting equipment to install system on the outside of the fuel tank.
- E. Provide Donaldson TRAP breather filter and replace manufacturers standard mushroom cap on normal vent.
 - 1. This will filter vent air and help strip moisture to prevent condensation from building up within the tank.

- F. Provide Morrison Bros. Co 178 series sealable, lockable cap and replace manufacturers standard existing turtle cap.
 - 1. A sealable cap will help prevent water entry and help direct all vent air to the standard normal vent pipe.
- G. Provide Morrison Bros. Co 244 series UL listed emergency vent in addition to the normal vent.
 - 1. Vent to be installed to help prevent the tank from becoming over-pressurized and possibly rupturing if ever exposed to fire.

2.8 OUTDOOR WEATHER PROTECTIVE ENCLOSURE

- A. The generator set shall be provided with an outdoor enclosure, with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure and sub-base fuel tank (when used) shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100°F. The housing shall have hinged 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-hygroscopic materials.

2.9 GENERATOR SET CONTROL PANEL

- A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- B. The control shall be mounted on the generator set or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- C. The generator set mounted control shall include the following features and functions:
 1. Mode Select Switch: The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position the generator set shall start and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF Position the generator set shall immediately stop, bypassing all time delays. In the AUTO Position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 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.

2.10 REMOTE ANNUNCIATOR PANEL

- A. Provide a 16-light minimum LED type remote alarm annunciator with horn.
1. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for Level 1 systems for the local generator control panel.
 2. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator.
 3. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided.
 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 DIESEL GENERATOR SCOPE OF WORK

- A. The Electrical Contractor shall properly seal and caulk all new pipes and fittings to prevent water entry.
- B. The Electrical Contractor shall provide diesel fuel to fill tank.
- C. The Electrical Contractor shall connect the spill alarm panel to a spare light on the remote annunciator. Label light to indicate spill alarm panel.

- D. The Electrical Contractor shall connect the low fuel and rupture basin alarms to spare lights on the remote annunciator. Label lights to indicate low fuel and rupture basin alarms.
- E. The Electrical Contractor shall provide a concrete pad with frost walls and piers as required to support the generator working platform.
- F. When the fuel maintenance system is included:
 - 1. The Electrical Contractor shall connect the 24V DC, N.O. leak detector on the fuel maintenance system to the leak detection alarm panel. Provide wiring/conduit as required.
 - 2. The Electrical Contractor shall provide (2) 1P.20A circuit breakers in closest normal/emergency panel and connect to the fuel maintenance system & the fuel maintenance system heater with 4#10 + 1#10 gnd in 1" conduit unless otherwise noted.
 - 3. The Electrical Contractor shall provide a spare 1" conduit between the fuel maintenance system and the building for the Modbus wiring.
 - 4. The Plumbing Contractor shall provide fuel piping between the tank and the fuel maintenance system as required by the manufacturer.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide flexible conduit and hoses in all electrical, fuel, cooling, exhaust, and lubrication lines which connect to the engine generator set. Install flexible lines to avoid interference with the operation of vibration isolators.
- C. Install conduits and piping to enter enclosures through the floor or as indicated. Do not penetrate removable or hinged panels or structural members above the skid base.
- D. Provide all fuel piping and connections required.
- E. Provide flexible conduit at connections to generator.
- F. Provide open space where conduits connect to generator.
- G. Install remote annunciator at location shown on the drawings. When not shown on the drawings, install in a location readily observed/monitored by facility personnel. Provide 1" conduit between generator and remote annunciator with wiring required.
- H. Install emergency stop at location shown on the drawings or at location coordinated with Engineer.
- I. Provide connection point for ATC System to monitor if the generator is on or off.
- J. Provide a 1P.20A circuit breaker in closest panel and connect to battery charger and additional generator equipment with 2#10 + 1#10 gnd in 3/4" conduit unless otherwise noted.

- K. Provide a 1P.30A circuit breaker in closest panel and connect to block heater with 2#10 + 1#10 gnd in 3/4" conduit unless otherwise noted. Provide breaker and wire sizes recommended by manufacturer.
- L. Install a sign at the main switchgear noting the location of the emergency generator: ie: "NOTE: EMERGENCY GENERATOR LOCATED OUTSIDE OF BUILDING".
- M. For non-separately derived generators (solid neutral) provide an additional sign at the service entrance equipment with the following warning in accordance with NEC 700.7.B: "WARNING SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER 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 – AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Automatic Transfer Switches

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. UL 1008 – Standard for Automatic Transfer Switches
- C. NFPA 99 – Essential Electrical Systems for Health Care Facilities
- D. NFPA 110 – Emergency and Standby Power Systems
- E. IEEE Standard 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- F. NEMA Standard ICS10-1993 (formerly ICS2-447) – AC Automatic Transfer Switches
- G. NEC Articles 700, 701, 702
- H. International Standards Organization ISO 9001: 2008
- I. IEC 60947-6-1

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. Basis of Design: ASCO – 300 Series (3ATS)
- B. Alternate Manufacturers:
 - 1. Onan Corporation
 - 2. Kohler Power Systems

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 electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include over current disconnect devices will not be accepted. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.
- 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 800 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. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.

- 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 ATS 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.

2.4 GROUP 'G' CONTROLLER WITH INTEGRATED USER INTERFACE PANEL

- A. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.
- B. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, inherent serial communications capability, and the ability to communicate via the Ethernet through optional communications module
- C. A single controller shall provide single and three phase capability for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.1\text{Hz}$. Time delay settings shall be accurate to $\pm 0.5\%$ of the full scale value of the time delay. The panel shall be capable of operating over a temperature range of -20 to + 70 degrees C, and storage from - 55 to + 85 degrees C.
- D. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards.
- E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
 - 1. IEC 60947 – 6 – 1 Multiple Function Equipment Transfer Switching Equipment. 61000-4 Testing And Measurement Techniques - Overview
 - a. IEC 61000 – 4 – 2 Electrostatic Discharge Immunity
 - b. IEC 61000 – 4 – 3 Radiated RF Field Immunity
 - c. IEC 61000 – 4 – 4 Electrical Fast Transient/Burst Immunity
 - d. IEC 61000 – 4 – 5 Surge Immunity
 - e. IEC 61000 – 4 – 6 Conducted RF Immunity
 - 2. CISPR 11 – Conducted RF Emissions and Radiated RF Emissions

2.5 ENCLOSURE

- A. Enclosure:
 - 1. Interior Locations: Type 1
 - 2. Exterior Locations: Type 3R

- a. Provide strip heater with thermostat for Type 3R enclosure requirements.
- B. Controller shall be mounted on, visible, and operational through enclosure door.

2.6 ADDITIONAL FEATURES

- A. The user interface shall be provided with test/reset modes. The test mode will simulate a normal source failure. The reset mode shall bypass the time delays on either transfer to emergency or retransfer to normal.
- B. A set of contacts rated 5 amps, 30 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down. setting, regardless of whether the normal source restores before the load is transferred.
- C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed when the ATS is connected to the emergency source.
- D. A single alarm indication shall light up the alert indicator and de – energize the configured common alarm output relay for external monitoring.
- E. LED indicating lights shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).
- F. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal (green) and emergency (red) source, as determined by the voltage sensing trip and reset settings for each source.
- G. LED indicating light shall be provided to indicate switch not in automatic mode (manual); and blinking (amber) to indicate transfer inhibit.
- H. LED indicating light shall be provided to indicate any alarm condition or active time delay (red).

2.7 OPTIONAL FEATURES

- A. Provide the following optional features:
 - 1. Accessory 11BE – Accessory bundle includes the following:
 - a. A fully programmable engine exerciser with seven independent routines to exercise the engine generator, with or without load on a daily weekly, bi – weekly, or monthly basis.
 - b. Event log display that shows event number, time and date of events, event type, and reason (if applicable). A minimum of 300 events shall be stored.
 - c. RS – 485 communications port enabled.
 - d. Common alarm output contact.
 - 2. Accessory 18RX – Expansion Module:
 - a. A relay expansion module (REX) is a standard feature when delayed transition transfer is specified. A REX module shall also be provided for open transition

transfer that includes one form C contact for source availability of the normal (18G) and emergency (18B) sources. Additional output relay shall be provided to indicate a common alarm. The REX module shall have the capability of being daisy chained for multiple sets of contacts.

3. Accessory 44G – Enclosure Heater:
 - a. A 125 watt enclosure heater with transformer and thermostat (adjustable from 30 deg to 140 deg F).
 - b. Provide when transfer switch is located outdoors.

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 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 TESTS AND CERTIFICATION

- A. The complete 3ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer

time, voltage, frequency and time delay settings are in 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 ATS 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 interwiring 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 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.

3.8 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 263604 – NON-AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Non-automatic transfer switches with Quick Connect Input and Output Power Panels.

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code
- B. UL 1008 – Standard for Automatic Transfer Switches
- C. IEC 60947-6-1 Low – Voltage Switchgear and Controller
- D. NFPA 99 – Essential Electrical Systems for Health Care Facilities
- E. NFPA 110 – Emergency and Standby Power Systems
- F. IEEE Standard 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- G. NEMA Standard ICS10-1993 (formerly ICS2-447) – AC Automatic Transfer Switches
- H. NEC Articles 700, 701, 702
- I. International Standards Organization ISO 9001: 2008
- J. IEC 60947-6-1

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: ASCO – 300 Series (3NTS)
- B. Alternate Manufacturers:
 - 1. Trystar

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 electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include overcurrent disconnect devices will not be accepted. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.
- 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 800 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. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually

stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.

- 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 NTS 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.

2.4 GROUP 'G' CONTROLLER WITH INTEGRATED USER INTERFACE PANEL

- A. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.
- B. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, inherent serial communications capability, and the ability to communicate via the Ethernet through optional communications module
- C. A single controller shall provide single and three phase capability for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.1\text{Hz}$. Time delay settings shall be accurate to $\pm 0.5\%$ of the full scale value of the time delay. The panel shall be capable of operating over a temperature range of -20 to $+ 70$ degrees C, and storage from -55 to $+ 85$ degrees C.
- D. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards.
- E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
 - 1. IEC 60947 – 6 – 1 Multiple Function Equipment Transfer Switching Equipment, 61000-4 Testing And Measurement Techniques - Overview
 - a. IEC 61000 – 4 – 2 Electrostatic Discharge Immunity
 - b. IEC 61000 – 4 – 3 Radiated RF Field Immunity
 - c. IEC 61000 – 4 – 4 Electrical Fast Transient/Burst Immunity
 - d. IEC 61000 – 4 – 5 Surge Immunity
 - e. IEC 61000 – 4 – 6 Conducted RF Immunity
 - 2. CISPR 11 – Conducted RF Emissions and Radiated RF Emissions

2.5 ENCLOSURE

- A. Enclosure:
 - 1. Interior Locations: Type 1
 - 2. Exterior Locations: Type 3R
 - a. Provide strip heater with thermostat for Type 3R enclosure requirements.
- B. Controller shall be mounted on, visible, and operational through enclosure door.

2.6 ADDITIONAL FEATURES

- A. The user interface shall be provided with a soft key to transfer between the normal and emergency sources.
- B. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed when the ATS is connected to the emergency source.
- C. A single alarm indication shall light up the alert indicator, and de – energize the configured common alarm output relay for external monitoring.
- D. A test soft key shall be provided to simulate a normal source failure.
- E. A reset soft key shall be provided to bypass the time delay on transfer to emergency.
- F. LED indicating lights shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).
- G. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal (green) and emergency (red) source, as determined by the voltage sensing trip and reset settings for each source.
- H. LED indicating light shall be provided to indicate switch not in automatic mode (manual); and blinking (amber) to indicate transfer inhibit.
- I. LED indicating light shall be provided to indicate any alarm condition or active time delay (red).

2.7 OPTIONAL FEATURES

- A. Provide the following optional features:
 - 1. Accessory 11BE – Accessory bundle includes the following:
 - a. A fully programmable engine exerciser with seven independent routines to exercise the engine generator, with or without load on a daily weekly, bi – weekly, or monthly basis.
 - b. Event log display that shows event number, time and date of events, event type, and reason (if applicable). A minimum of 300 events shall be stored.
 - c. RS – 485 communications port enabled.
 - d. Common alarm output contact.

2. Accessory 44A – Enclosure Heater:
 - a. A 125 watt enclosure heater with transformer and thermostat (adjustable from 30 deg to 140 deg F).
 - b. Provide when transfer switch is located outdoors.
3. Accessory 130QL4 –
 - a. Aluminum receptacle housing mounted on the left side of Type 3R transfer switch enclosure. Contains 16 Series Camlock connectors wired to emergency side of the transfer switch for connections to alternate source.
 - b. Provide connector configuration to match generator.

2.8 QUICK CONNECT INPUT AND OUTPUT POWER PANELS

A. General

1. Quick Connect Input Power panels shall provide a convenient, reliable and economical way to connect temporary emergency power from portable generators to a facility in conjunction with an ASCO transfer switch. Quick Connect Output Panels shall provide a convenient way to connect load banks to a facility.
2. The Quick Connect Power panels shall be available in rating configurations from 400 Amp to 4000 Amp Service. Input Panels shall be listed to UL 1008 as a transfer switch accessory; Output Panels shall be listed to UL 891 for Switchboards.
3. Quick Connect Power Panels shall be ASCO 300 Series (3QC).

B. Mechanical

1. All quick connect power panels shall be Type 3R compliant and constructed of aluminum, mild steel or Stainless Steel. The Type 3R rating shall be maintained with the temporary cables installed.
2. Cables shall enter and exit the wiring chamber via access holes specifically designed for conductors and shall be provided with a bushing or shall be formed so that there are no sharp edges with which conductor insulation may come in contact.
3. Connections shall be arranged so that cables drape downward when connected.

C. Electrical

1. The quick connect panel shall have input and output connections rated up to 600 VAC, as specified in the contract documents.
 - a. Input Panels - Recessed male connectors
 - b. Output Panels - Female connectors with flip covers.
2. All electrical connectors shall be cam type single pole connectors compatible with Maringo or Leviton 16 Series CAM Locks™ and available color coded as per industry standard practice:
 - a. 240V and below: phase 1 = black, phase 2 = red, phase 3 = blue.
 - b. 480V: phase 1 = brown, phase 2 = orange, phase 3 = yellow.
 - c. Ground shall always be green.
 - d. Neutral shall always be white.

D. Compliance

1. The 400-4000 Amp quick connect Input panel must be listed to UL 1008 under Annex J as a Transfer Switch Accessory. Output Panel must be listed to UL 891 for Panelboards.

2. "Built to the standard" shall not be allowed: the quick connect panels shall be tested in accordance with and listed to UL 1008 or UL 891 standards.
 3. UL 50 Listed enclosures may be used but only listed to UL 50 shall not be acceptable.
- E. Provide quick connect input and output power panel as required for application.

2.9 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 pad for indoor floor mounted transfer switches.
- B. Provide pad with frost walls similar to generator for outdoor applications.

3.3 INSTALLATION

- A. Install transfer switches in accordance with manufacturer's instructions.
- B. Provide control wiring required between generator set and transfer switches.
- C. 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 NTS 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 NTS 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 263604

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

(Addendum 5)

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
 - D. CRI: 70 or greater

- E. Operating Temperature: -30°C to +40°C
- F. Driver Power Factor: Greater than 0.9
- G. Driver THD: Less than 20%
- H. Provide light emitting diodes with individual injection molded acrylic optics.

2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 - 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-stage type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80% of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- C. Wireguards: Provide wireguards for all exit signs located in the Gymnasiums, Locker Rooms, Multi-Purpose Rooms, Electrical Rooms, Mechanical Rooms, Boiler Rooms, and all other areas indicated on the drawings.

2.5 FINISHES

- A. Manufacturer's standard color, unless otherwise indicated in Luminaire Schedule to be "custom color".

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2" steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

- 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. When a DMX Driver is specified, program each luminaire with a DMX address.
- S. Program a DMX address for each luminaire before installing luminaires. Coordinate addresses with Owner and Control Manufacturer.
- T. Bond products and metal accessories to branch circuit equipment grounding conductor.
- U. 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.
- V. Appurtenances: Install each luminaire properly and safely. Furnish and erect hangers, rods, mounting brackets, supports, frames, and other equipment required.
- W. 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.
- X. Install lighting luminaires in strict conformance with the luminaire manufacturer's recommendations and instructions.
- Y. Rigidly align continuous rows of lighting luminaires for true in-line appearance.
- Z. 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.
- AA. 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.
- BB. 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.
- CC. 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 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
- D. CRI: 70 or greater
- E. Operating Temperature: -30°C to +40°C
- F. Driver Power Factor: Greater than 0.9
- G. Driver THD: Less than 20%
- H. Provide light emitting diodes with individual injection molded acrylic optics.

2.4 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4M.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot dip galvanized after fabrication unless otherwise indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
- D. Handhole: Oval-shaped, with minimum clear opening of 2.5" x 5" with cover secured by stainless-steel captive screws.
- E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-In-Place Concrete"

2.5 STEEL POLES

- A. Poles: Comply with ASTM A500, Grade B, carbon steel with a minimum yield of 46,000-psi (317 MPa); 1-piece construction up to 40' in height 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.
- B. Steel Mast Arms: Continuously welded to pole attachment plate. Material and finish same as pole.
- 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 .5" threaded lug, complying with requirements in Section 260170, listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- E. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- F. Factory-Painted Finish: 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 with SSPC-SP 8, "Pickling".

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. 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.

2.6 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.

2.7 POLE ACCESSORIES

- A. Base Covers: Manufacturers standard metal units, arranged to cover pole's mounting bolts and nuts. Provide 1 for every pole.

2.8 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 265669 – EXTERIOR ATHLETIC LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work covered by this section of the specifications shall conform to the contract documents, engineering plans as well as state and local codes.
- B. The purpose of these specifications is to define the lighting system performance and design standards using an LED Lighting source. The manufacturer / contractor shall supply lighting equipment to meet or exceed the standards set forth in these specifications.
- C. The sports lighting will be for the following venues:
 - 1. Field Hockey/Soccer
 - 2. ***Multipurpose Field (Bid Alternate EC-5 – Refer to Section 012300 and Electrical Site Plans for additional information)***

(Addendum 5)

- D. The primary goals of this sports lighting project are:
 - 1. Guaranteed Light Levels: Selection of appropriate light levels impact the safety of the players and the enjoyment of spectators. Therefore, light levels are guaranteed to not drop below specified target values for a period of 25 years.
 - 2. Environmental Light Control: It is the primary goal of this project to minimize spill light to adjoining properties and glare to the players, spectators, and neighbors.
 - 3. Cost of Ownership: In order to reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate. All maintenance costs shall be eliminated for the duration of the warranty.
 - 4. All lighting designs shall comply with PIAA published lighting standards and local municipality ordinance requirements.
 - 5. Control and Monitoring: To allow for optimized use of labor resources and avoid unneeded operation of the facility, customer requires a remote on/off control system for the lighting system. Fields should be proactively monitored to detect luminaire outages over a 25-year life cycle. All communication and monitoring costs for 25-year period shall be included in the bid.

1.2 LIGHTING PERFORMANCE

- A. Illumination Levels and Design Factors: Playing surfaces shall be lit to an average target illumination level and uniformity as specified in the chart below. Lighting calculations shall be developed, and field measurements taken on the grid spacing with the minimum number of grid points specified below. Appropriate light loss factors shall be applied and submitted for the basis of design. Average illumination level shall be measured in accordance with the IESNA LM-5-04 (IESNA Guide for Photometric Measurements of Area and Sports Lighting Installations).

Illumination levels shall not to drop below desired target values in accordance with IES RP-6-15, Page 2, Maintained Average Illuminance and shall be guaranteed for the full warranty period.

Area of Lighting	Average Target Illumination Levels	Maximum to Minimum Uniformity Ratio	Grid Points	Grid Spacing
Field Hockey/Soccer	50fc	2:1	77	30'x30'
Multipurpose	50fc	2:1	96	30'x30'

- B. Color: The lighting system shall have a minimum color temperature of 5700K and a CRI of 75.
- C. Mounting Heights: To ensure proper aiming angles for reduced glare and to provide better playability, minimum mounting heights shall be as described below. Higher mounting heights may be required based on photometric report and ability to ensure the top of the field angle is a minimum of 10° below horizontal.

# of Poles	Pole Designation	Pole Height
4	S1-S4	70'
4	S5-S8	80'

1.3 ENVIRONMENTAL LIGHT CONTROL

- A. Light Control Luminaires: All luminaires shall utilize spill light and glare control devices including, but not limited to, internal shields, louvers, and external shields. No symmetrical beam patterns are accepted.
- B. Spill Light and Glare Control: To minimize impact on adjacent properties, spill light and candela values must not exceed the following levels taken at 3 feet above grade.

	Average	Maximum
Property Line Spill – Specified Spill Line Horizontal Footcandles	0.10 fc	0.97 fc

- C. Spill Scans: Spill scans must be submitted indicating the amount of horizontal footcandles along the specified lines. Light levels shall be provided in 30-foot intervals along the boundary line at 3 ft above grade. Environmental glare impact scans must be submitted showing the maximum candela from the field edge on a map of the surrounding area until 7,500 candela or less is achieved.
- D. Sample Photometry: The first page of a photometric report for all luminaire types proposed showing horizontal and vertical axial candle power shall be provided to demonstrate the capability of achieving the specified performance. Reports shall be certified by a qualified testing laboratory with a minimum of five years experience or by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products. A summary of the horizontal and vertical aiming angles for each luminaire shall be included with the photometric report.

- E. Field Verification: Lighting manufacturer shall supply field verification of environmental light control using a meter calibrated within the last 12 months:
 - 1. Spill verification: Illumination levels shall be taken in accordance with IESNA RP-6-22. The light sensing surface of the light meter should be held 36 inches above the playing surface with the sensing surface horizontal (for horizontal readings) or vertically pointed at the brightest light bank (for max vertical readings).

1.4 COST OF OWNERSHIP

- A. Manufacturer shall submit a 25-year Cost of Ownership summary that includes energy consumption, anticipated maintenance costs, and control costs. All costs associated with faulty luminaire replacement - equipment rentals, removal and installation labor, and shipping - are to be included in the maintenance costs.

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 luminaires arranged in order of luminaire designation.
 - c. Detailed luminaire and pole information.
 - d. Footcandle Layout Drawings.
 - e. Control System Summary.
 - f. Foundation base sealed by a Pennsylvania Professional Engineer.
 - g. All warranties for system.

1.6 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 final As-Built shop drawings.

PART 2 - PRODUCT

2.1 SPORTS LIGHTING SYSTEM CONSTRUCTION

- A. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaires, wire harnesses, drivers and other enclosures shall be factory assembled, aimed, wired, and tested.

- B. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking. Structural fasteners may be carbon steel and galvanized meeting ASTM A153 and ISO/EN 1461 (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing). All wiring shall be enclosed within the cross-arms, pole, or electrical components enclosure.
- C. System Description: Lighting system shall consist of the following:
1. Galvanized steel poles and cross-arm assembly.
 2. Non-approved pole technology:
 - a. Square static cast concrete poles will not be accepted.
 - b. Direct bury steel poles which utilize the extended portion of the steel shaft for their foundation will not be accepted due to potential for internal and external corrosive reaction to the soils and long-term performance concerns.
 3. Lighting systems shall use concrete foundations. See Section 2.4 for details.
 - a. For a foundation using a pre-stressed concrete base embedded in concrete backfill the concrete shall be air-entrained and have a minimum compressive design strength at 28 days of 3,000 PSI. 3,000 PSI concrete specified for early pole erection actual required minimum allowable concrete strength is 1,000 PSI. All piers and concrete backfill must bear on and against firm undisturbed soil.
 - b. For anchor bolt foundations or foundations using a pre-stressed concrete base in a suspended pier or reinforced pier design pole erection may occur after 7 days. Or after a concrete sample from the same batch achieves a certain strength.
 4. Manufacturer will supply all drivers and supporting electrical equipment
 - a. Remote drivers and supporting electrical equipment shall be mounted approximately 10 feet above grade in aluminum enclosures. The enclosures shall be touch-safe and include drivers and fusing with indicator lights on fuses to notify when a fuse is to be replaced for each luminaire. Disconnect per circuit for each pole structure will be located in the enclosure. Integral drivers are not allowed.
 - b. Manufacturer shall provide surge protection at the pole equal to or greater than 40 kA for each line to ground (Common Mode) as recommended by IEEE C62.41.2_2002.
 5. Wire harness, complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.
 6. All luminaires, visors, and cross-arm assemblies shall withstand 150 mi/h winds and maintain luminaire aiming alignment.
 7. Control cabinet to provide remote on-off control, monitoring, and entertainment features of the lighting system. See Section 2.3 for further details.
 8. Manufacturer shall provide lightning grounding as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A.
 - a. Integrated grounding via concrete encased electrode grounding system.
 - b. If grounding is not integrated into the structure, the manufacturer shall supply grounding electrodes, copper down conductors, and exothermic weld kits. Electrodes and conductors shall be sized as required by NFPA 780. The grounding

electrode shall be minimum size of 5/8" diameter and 8' long, with a minimum of 10' embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2 AWG for poles with 75' mounting height or less, and 2/0 AWG for poles with more than 75' mounting height.

- D. Safety: All system components shall be UL listed for the appropriate application.

2.2 ELECTRICAL

- A. Electric Power Requirements for the Sports Lighting Equipment:
 - 1. Electric power: 480 Volt, 3 Phase
 - 2. Maximum total voltage drop: Voltage drop to the disconnect switch located on the poles shall not exceed three (3) percent of the rated voltage.
- B. Energy Consumption: The kW consumption for the field lighting system shall be 80.36.

2.3 CONTROL

- A. Instant On/Off Capabilities: System shall provide for instant on/off of luminaires.
- B. Lighting contactor cabinet(s) constructed of NEMA Type 4 aluminum, designed for easy installation with contactors, labeled to match field diagrams and electrical design. Manual off-on-auto selector switches shall be provided.
- C. Contactor control of lights: To minimize wear on drivers and other electrical components and prevent lights from turning on due to communication loss, circuits must be controlled via contactor switching, not dimming driver output to zero.
- D. Dimming: System shall provide for 3-stage dimming (high-medium-low). Dimming will be set via scheduling options (Website, app, phone, fax, email).
- E. Remote Lighting Control System: System shall allow owner and users with a security code to schedule on/off system operation via a web site, phone, fax or email up to ten years in advance. Manufacturer shall provide and maintain a two-way TCP/IP communication link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs.
 - 1. The owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling capabilities for all fields to only having permission to execute "early off" commands by phone. Scheduling tool shall be capable of setting curfew limits.
 - 2. Controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is regained and execute any commands that would have occurred during outage.
- F. Remote Monitoring System: System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The controller shall determine switch position (manual or auto) and contactor status (open or closed).

- G. Management Tools: Manufacturer shall provide a web-based database and dashboard tool of actual field usage and provide reports by facility and user group. Dashboard shall also show current status of luminaire outages, control operation and service. Mobile application will be provided suitable for IOS and Android devices.
- H. Hours of Usage: Manufacturer shall provide a means of tracking actual hours of usage for the field lighting system that is readily accessible to the owner.
 - 1. Cumulative hours: shall be tracked to show the total hours used by the facility
 - 2. Report hours saved by using early off and push buttons by users.
- I. Communication Costs: Manufacturer shall include communication costs for operating the control and monitoring system for a period of 25-years.
- J. Communication with luminaire drivers: Control system shall interface with drivers in electrical components enclosures by means of powerline communication.

2.4 STRUCTURAL PARAMETERS

- A. Wind Loads: Wind loads shall be based on the 2021 International Building Code. Wind loads to be calculated using ASCE 7-16, an ultimate design wind speed of 115 MPH and exposure category C.
- B. Pole Structural Design: The stress analysis and safety factor of the poles shall conform to 2013 AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LTS-6).
- C. Foundation Design: The foundation design shall be based on soils that meet or exceed those of a Class 5 material as defined by 2021 IBC Table 1806.2.
- D. Foundation Drawings: Project specific foundation drawings stamped by a registered engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole. These drawings must be submitted at time of bid to allow for accurate pricing.

PART 3 - EXECUTION

3.1 SOIL QUALITY CONTROL

- A. It shall be the Contractor's responsibility to notify the Owner if soil conditions exist other than those on which the foundation design is based, or if the soil cannot be readily excavated. Contractor may issue a change order request / estimate for the Owner's approval / payment for additional costs associated with:
 - 1. Providing engineered foundation embedment design by a registered engineer in the State of Pennsylvania for soils other than specified soil conditions.
 - 2. Additional materials required to achieve alternate foundation.
 - 3. Excavation and removal of materials other than normal soils, such as rock, caliche, etc.

3.2 DELIVERY TIMING

- A. Delivery Timing Equipment On-Site: The equipment must be on-site 8-10 weeks from receipt of approved submittals and receipt of complete order information.

3.3 FIELD QUALITY CONTROL

- A. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA RP-6-22.
- B. Field Light Level Accountability:
 - 1. Light levels are guaranteed not to fall below the target maintained light levels for the entire warranty period of 25-years. These levels will be specifically stated as "guaranteed" on the illumination summary provided by the manufacturer.
 - 2. The contractor/manufacturer shall be responsible for conducting initial light level testing and an additional inspection of the system, in the presence of the owner, one year from the date of commissioning of the lighting.
 - 3. The contractor/manufacturer will be held responsible for any and all changes needed to bring these fields back to compliance for light levels and uniformities. Contractor/Manufacturer will be held responsible for any damage to the fields during these repairs.
- C. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including footcandles and uniformity ratios are not in conformance with the requirements of the performance specifications and submitted information, the Manufacturer shall be required to make adjustments to meet specifications and satisfy Owner.

3.4 WARRANTY AND GUARANTEE

- A. 25-Year Warranty: Each manufacturer shall supply a signed warranty covering the entire system for 25 years from the date of shipment. Warranty shall guarantee specified light levels. Manufacturer shall maintain specifically funded financial reserves to assure fulfillment of the warranty for the full term. Warranty does not cover weather conditions events such as lightning or hail damage, improper installation, vandalism or abuse, unauthorized repairs or alterations, or product made by other manufacturers.
- B. Maintenance: Manufacturer shall monitor the performance of the lighting system, including on/off status, hours of usage and luminaire outage for 25-years from the date of equipment shipment. Parts and labor shall be covered such that individual luminaire outages will be repaired when the usage of any field is materially impacted. Manufacturer is responsible for removal and replacement of failed luminaires, including all parts, labor, shipping, and equipment rental associated with maintenance. Owner agrees to check fuses in the event of a luminaire outage.

PART 4 - DESIGN APPROVAL

4.1 PRE-BID SUBMITTAL REQUIREMENTS (Non-Musco)

- A. Design Approval: The owner / engineer will review pre-bid submittals per section 4.0.B from all the manufacturers to ensure compliance to the specification 10 days prior to bid. If the design meets the design requirements of the specifications, a letter and/or addendum will be issued to the manufacturer indicating approval for the specific design submitted.
- B. Approved Product: Musco's Light-Structure System™ with TLC for LED™ is the approved product. All substitutions must provide a complete submittal package for approval as outlined in Submittal Information at the end of this section at least 10 days prior to bid. Special manufacturing to meet the standards of this specification may be required. An addendum will be issued prior to bid listing any other approved lighting manufacturers and designs.
- C. All listed manufacturers not pre-approved shall submit the information at the end of this section at least 10 days prior to bid. An addendum will be issued prior to bid; listing approved lighting manufacturers and the design method to be used.
- D. Bidders are required to bid only products that have been approved by this specification or addendum by the owner or owner's representative. Bids received that do not utilize an approved system/design, will be rejected.

REQUIRED SUBMITTAL INFORMATION FOR ALL MANUFACTURERS (NOT PRE-APPROVED) 10 DAYS PRIOR TO BID

*All items listed below are mandatory, shall comply with the specification and be submitted according to pre-bid submittal requirements. Complete the Yes/No column to indicate compliance (Y) or noncompliance (N) for each item. **Submit checklist below with submittal.***

Yes/ No	Tab	Item	Description
	A	Letter/ Checklist	Listing of all information being submitted must be included on the table of contents. List the name of the manufacturer's local representative and his/her phone number. Signed submittal checklist to be included.
	B	Equipment Layout	Drawing(s) showing field layouts with pole locations
	C	On Field Lighting Design	Lighting design drawing(s) showing: a. Field Name, date, file number, prepared by b. Outline of field(s) being lighted, as well as pole locations referenced to the center of the field (x & y), Illuminance levels at grid spacing specified c. Pole height, number of fixtures per pole, horizontal and vertical aiming angles, as well as luminaire information including wattage, lumens and optics d. Height of light test meter above field surface. e. Summary table showing the number and spacing of grid points; average, minimum and maximum illuminance levels in foot candles (fc); uniformity including maximum to minimum ratio, coefficient of variance (CV), coefficient of utilization (CU) uniformity gradient; number of luminaires, total kilowatts, average tilt factor; light loss factor.
	D	Off Field Lighting Design	Lighting design drawing showing initial spill light levels along the boundary line (defined on bid drawings) in footcandles. Lighting design showing glare along the boundary line in candela. Light levels shall be taken at 30-foot intervals along the boundary line. Readings shall be taken with the meter orientation at both horizontal and aimed towards the most intense bank of lights.
	E	Photometric Report	Provide first page of photometric report for all luminaire types being proposed showing candela tabulations as defined by IESNA Publication LM-35-02. Photometric data shall be certified by laboratory with current National Voluntary Laboratory Accreditation Program or an independent testing facility with over 5 years' experience.
	F	Performance Guarantee	Provide performance guarantee including a written commitment to undertake all corrections required to meet the performance requirements noted in these specifications at no expense to the owner. Light levels must be guaranteed to not fall below target levels for warranty period.
	G	Structural Calculations	Pole structural calculations and foundation design showing foundation shape, depth backfill requirements, rebar, and anchor bolts (if required). Pole base reaction forces shall be shown on the foundation drawing along with soil bearing pressures. Design must be stamped by a structural engineer in the state of PA, if required by owner.
	H	Control & Monitoring System	Manufacturer of the control and monitoring system shall provide written definition and schematics for automated control system. They will also provide ten (10) references of customers currently using proposed system in the state of Pennsylvania.

I	Electrical Distribution Plans	Manufacturer bidding an alternate product must include a revised electrical distribution plan including changes to service entrance, panels and wire sizing, signed by a licensed Electrical Engineer in the state of Pennsylvania.
J	Warranty	Provide written warranty information including all terms and conditions. Provide ten (10) references of customers currently under specified warranty in the state of PA.
K	Project References	Manufacturer to provide a list of ten (10) projects where the technology and specific fixture proposed for this project has been installed in the state of Pennsylvania. Reference list will include project name, project city, installation date, and if requested, contact name and contact phone number.
L	Product Information	Complete bill of material and current brochures/cut sheets for all products being provided.
M	Delivery	Manufacturer shall supply an expected delivery timeframe from receipt of approved submittals and complete order information.
N	Non-Compliance	Manufacturer shall list all items that do not comply with the specifications. If in full compliance, tab may be omitted.
O	Cost of Ownership	Document cost of ownership as defined in the specification. Identify energy costs for operating the luminaires. Maintenance cost for the system must be included. All costs should be based on 25 Years.

The information supplied herein shall be used for the purpose of complying with the specifications for Northern York High School. By signing below, I agree that all requirements of the specifications have been met and that the manufacturer will be responsible for any future costs incurred to bring their equipment into compliance for all items not meeting specifications and not listed in the Non-Compliance section.

Manufacturer: _____

Signature: _____

Contact Name: _____

Date: ____/____/____

Contractor: _____

Signature: _____

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.
- B. Wire Rod Type Cable Tray:
 1. Refer to Section 260536 for wire rod type cable tray.

2.5 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

- A. Refer to Section 260533 for raceways and boxes.

2.6 FLAT PANEL MASONRY WALL BOXES

- A. The flat panel masonry wall box is a dedicated flat panel TV project box engineered for installation in 8" block walls. The all-metal box is designed to replace the front portion of one block and provides an attractive surface with the optional paintable cover with no visible jagged block edges. The box has two opposing 2-gang device boxes inside, providing space for power and low voltage devices, including most receivers.
- B. The box has available 1", 1.25", and 1.5" knockouts centered on the opening of the most common two-hole CMU blocks. This project wall box ships with a construction cover for the rough-out phase.
- C. Inside the box, two 2-gang compartments face the middle and accommodate standard electrical plates. These compartments are convertible to a single gang with the provided block-off plates; & are also removable for installing active brick receivers. The gang compartments are oversized to allow for extra service loops & cable storage and have a depth of 3.25" to allow for the largest active electronic wall plates.
- D. Provide FSR Inc model PWB-CMU8-B box with PWB-CMU8-WHT-C metal cover at wall mount tv locations installed in block walls.
 - 1. Hubbell model HRWB25WHT shall be an approved equal.

2.7 FLAT PANEL STUD WALL BOXES

- A. The wall box is the essential installation accessory for any flat panel display. It installs easily in the wall behind any display allowing your screen to sit flush against the wall. This unit provides a neat and secure environment for audio, video, control and power connections.
- B. The wall box is 11"W x 5.25"H x 3.57"D and installs easily between any two standard studs in the wall. Once populated the overall height is 7.39" behind the wall. Connections and cable entry can be on the top or the bottom depending on installation preference. Designed to mount along the bottom edge behind a flat panel display, the wall box provides a single point for all your connections.
- C. Provide FSR Inc model PWB-100 box with PWB-100-XXXI cover at wall mount tv locations installed in stud walls.
 - 1. Hubbell model NSAV62M shall be an approved equal.

2.8 OWNER FURNISHED EQUIPMENT FOR INSTALLATION

- A. Wireless Access Points.
- B. Wall Mounted Televisions and associated mounting brackets.
- C. Projectors and associated mounting brackets.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Verify locations and mounting heights with the communications equipment.
- B. Install Owner furnished equipment.

3.2 GROUNDING AND BONDING INSTALLATION

- A. Main Telecommunications Ground Bus: Connect to the following:
 - 1. CATV entrance ground lug with #6 copper – green insulation.
 - 2. Telephone entrance protector with #6 copper – green insulation.
 - 3. Bond to metal water pipe with #6 copper – green insulation. (Provide 1" conduit where run is over 3' away.)
 - 4. Bond to building roof steel with #6 copper – green insulation. (Provide 1" conduit where run is over 3' away.)
 - 5. Ground counterpoise with #3/0 copper – green insulation in 1-1/2" conduit.
 - 6. Main service entrance equipment ground bus with #3/0 copper – in 1-1/2" conduit.
 - 7. MDF rack ground bus with #3/0 copper – (Provide in 1-1/2" conduit when not in cable tray).
- B. MDF Rack Ground Bus shall connect to the following:
 - 1. Each IDF in the project with #1/0 copper – green insulation via cable tray and 1-1/4" conduit. Bond to cable tray near IDF and MDF Racks.
 - 2. Bond to rack with #6 copper – green insulation.
 - 3. Building structural steel with #6 copper – green insulation.
- C. IDF Rack Ground Bus shall connect to the following:
 - 1. Additional IDF racks with #6 copper – green insulation. Lateral bonding between all IDF Racks.
 - 2. Bond to rack with #6 copper – green insulation.
 - 3. Building structural steel with #6 copper – green insulation.
- D. Wire Rod Type Cable Tray (Section 260536): Provide #2 bare copper conductor, entire length of cable tray. Bond at 50' intervals.
- E. 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.
- F. Comply with Section 260526, 270500 and applicable details on plans.
- G. Provide connections to the main ground bus on all backboards, telephone line protectors, IDF Racks and MDF Racks in the project.
- H. 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. Provide cable tray as required to support all communications cabling.
- C. Comply with all installation requirements of Sections 260529 and 260536.

3.5 CONDUITS AND BACKBOXES INSTALLATION

- A. Provide raceways and boxes as required for communications cabling.
- B. Comply with all installation requirements of Section 260533.
- C. Except for recessed outlet boxes in masonry walls or communication outlets provided in a shared outlet box with a wiring device (i.e., receptacle) using an internal outlet box partition, the minimum outlet box size consist of two or larger-gang box with a minimum depth of 2-3/4 inches, inclusive of any mud and/or tile ring depth, unless otherwise noted. Provide mud and/or tile ring with appropriate gang opening size as required. Communication outlet boxes installed recessed in masonry walls shall be a single or larger-gang outlet box with a minimum on 2-3/4 inches will be permitted unless otherwise noted.
- D. The minimum conduit size for communication conduit pathways and stub-outs shall be 1-inch.

3.6 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.

- F. Extend sleeves installed in floors 2" above finished floor level.
- G. Size pipe sleeves to provide 1/4" annular clear space between sleeve and pathway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
- K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1" annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.7 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 COMMUNICATIONS SYSTEM WIRING METHODS

- A. Provide communication pathways as required in accordance with the following paragraphs. Where communication wiring is required by other specification sections, provide communications wiring in accordance with the following paragraphs.
 - 1. Wire Routing: Route all device wiring from each device up into accessible ceiling cavity within metallic conduit in recessed or unfinished areas and within surface raceway for renovated non-fishable areas. Stub all conduits into accessible ceiling cavity and provide bushing for each.

2. Cable Routing: Route cable for all device wiring within accessible ceiling cavities. Install cable supports at 4' spacing maximum or in cable tray where applicable. No cabling is to lie on or attach to ceiling tile, ducts, pipes, conduits or ceiling suspension wires, rods, or structural members. Provide conduit stubs from devices and panels to the ceiling cavities. Use cable tray for support when it is shown on the drawings.
3. Route all system wiring from system equipment within metallic conduit up into nearby ceiling cavity and connect to the wiring system indicated in 1 and 2 above. Provide bushings at conduit ends.
4. Provide raceways for all communications cabling in all open structure ceiling spaces.
5. Refer to individual sections for methods specific to that system.

3.9 CEILING TILE REMOVAL

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

END OF SECTION 270500

SECTION 271100 – COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment Racks/Enclosures
- B. Wire Management
- C. Stand Off Brackets
- D. Cable Ladder
- E. 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 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.

2.3 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

2.4 CABLE LADDER

- 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

2.5 IDENTIFICATION

- A. Engraved plastic nameplates: Engraving stock, melamine plastic laminate, minimum 1/16" thick for nameplates up to 20 sq. in. and 1/8" thick for larger sizes.
 - 1. Engraving legend shall be black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
- B. Fasteners for Nameplates: Self-tapping, stainless-steel screws or #10/32 stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Provide horizontal and vertical cable management in all racks, on all backboards and any other location cabling is not routed in conduit or cable tray. Size cable management for 50% additional cables.
- B. Wiring within IDF/MDF and Enclosures: Provide adequate length of conductors. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- C. Install a 1 rack unit blank filler plate between patch panels which contain more than 12 jacks.
- D. Provide blank filler plates as required to fill rack.
- E. Support raceways, cabinets, and all other equipment in accordance with manufacturer's instructions.
- F. Install backboards and cabinets plumb and attach securely to building wall at each corner and additional as necessary to obtain a firm mounting.
- G. Provide full assembly of all racks, equipment enclosures, cabinets and file servers with all accessories installed.
- H. Provide engraved plastic nameplates for each equipment rack and equipment enclosure with 1/2" high lettering. Label shall include the following:
 - 1. Equipment Rack or Equipment Enclosure Name

3.3 GROUNDING

- A. Comply with Section 260526, 270500 and applicable details on plans.
- B. Provide connections to the main ground bus on all backboards, telephone line protectors, IDF Racks and MDF Racks in the project.
- 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 singlemode applications.
17. Inner tray shall have clips for cable ties, and holes to accept snap-in cable clips, front and rear, for complete cable management of patch cords and distribution cable strands.
18. Inner tray shall have rear cable tie-down features to accept various diameter backbone cables entering the enclosure.

D. Provide fiber panel sized for adapter panels + 20% spare.

2.2 FIBER OPTIC ADAPTER PANELS

A. Manufacturers:

1. Hubbell Premise Wiring
2. The Siemon Company

3. Systimax GigaSpeed Products
4. Leviton

B. Basis of Design – Hubbell Premise Wiring FSP Series Fiber Adapter Panels

C. Design Requirements:

1. Fiber adapter panels shall be a modular, quick-fastening steel plate, powder coated to match the enclosure finish.
2. Fiber adapter panels shall have pre-installed LC fiber adapters, available in low- or high-density multi-mode or single-mode applications.
3. Each individually bagged unit delivered shall consist of: (1) fully assembled adapter panel, with push-pull fasteners pre-installed.
4. Adapter panels shall be constructed of 16-ga cold rolled steel.
5. Finish shall be black durable powder coat on all surfaces.
6. Basic dimensions of the FSP panels shall be 5.10" length by 1.10" wide.
7. Panels shall have two pre-installed, push-pull type quick-release fasteners for quick snap-in installation. Push-pull fasteners shall have an industry standard center distance of 4.65".
8. Panels shall be suitable for mounting either vertically or horizontally.
9. Panels shall be available in with LC adapters with precision ceramic alignment sleeves.
10. All fiber adapters installed in FSP panels shall have dust caps installed.
11. Panels shall be available in low-density and high-density adapter patterns.

D. Fiber optic cable shall be terminated with LC OM4 50/125um Multimode or LC OS2 Singlemode connectors to fiber adapter panels mounted in Hubbell FCR series fiber optic enclosures with at least 50% spare capacity.

E. Provide port quantities to match the fiber optic cables + 20% spare unless otherwise noted on the Drawings.

2.3 FIBER OPTIC CONNECTORS

A. Manufacturers:

1. Hubbell Premise Wiring
2. The Siemon Company
3. Systimax GigaSpeed Products
4. Leviton
5. Corning

B. Basis of Design – Hubbell Splice-On Connectors to maintain the 25-year fiber warranty. PN#'s FCLCF900M50G6OK, FCLCF900SM6PK, FCSCF900M50G6PK, FCSCF900SM6PK.

C. Fiber optic cable shall be terminated with LC OM3 50/125um Multimode (LC OM4 50/125 um Multimode as required by distance application parameters) or LC OS2 Singlemode connectors to fiber adapter panels mounted in Hubbell FCR series fiber optic enclosures with at least 50% spare capacity.

D. Design Requirements:

1. Connector basic design shall be a factory pre-polished LC optical fiber connector with a zirconium ceramic ferrule. Integral with the connector body is a wedge-activated fiber clamping mechanism to secure the inserted fiber into a mechanical splice with the factory installed cleaved fiber stub. Index-matching gel is supplied factory-injected into the cleaved fiber stub splice to optimize transmission performance. Connector attachment is achieved without tools, by inserting a field-cleaved optical fiber and then extracting the disposable clamp wedges from the connector body.
2. Each basic connector unit delivered shall consist of: (1) connector body with disposable clamp wedge, (1) strain relief boot, and (1) plastic dust cap.
3. LC multimode factory pre-polished connectors shall be 50-micron laser optimized pre-installed fiber.
4. Connector termination method shall utilize an industry standard multi-layer strip tool and bare fiber cleave tool as the only field tools required.
5. LC connectors shall have features to enable field verification using a Visual Fault Locator (VFL) during termination.
6. Connector materials shall be designed with thermal stability to comply with environmental requirements of ANSI/TIA/EIA-568-C.3 and Telcordia GR-1081-CORE.
7. Multimode and singlemode pre-polished fiber connector materials shall be as follows:
 - a. Ferrule: zirconium ceramic
 - b. LC inner body: thermally stable injection molded thermoplastic
 - c. Dust Cap: nylon or PVC
 - d. Strain relief boot: UL94-V0 molded PVC
8. Pre-polished LC connectors shall require no field polishing.
9. Pre-polished MM LC connector body shall be industry standard aqua for 50-micron multimode, laser optimized colors for specific applications, as designated below:
10. Pre-polished MM LC connectors shall require no adhesives for termination.
11. LC connector internal fiber clamping mechanism shall firmly secure both the inserted glass fiber and the 900-micron buffer layer of the inserted fiber for maximum strain relief.
12. All standard mating and interface dimensions for LC connectors shall comply with ANSI/TIA/EIA-604-10 (FOCIS 10).
13. Ferrule outside diameter for LC multimode connectors shall be 1.2467mm to 1.2497mm.
14. Ferrule outside diameter for LC singlemode connectors shall be 1.2483mm to 1.2497mm.
15. LC ferrule tip shall have a PC spherical radius of approximately 7.0 mm radius for multimode and singlemode versions.
16. Delivered connectors shall be individually bagged with the dust cap installed to protect from contamination.
17. Delivered connectors shall have the disposable clamp activation wedge element pre-installed onto the connector body.
18. Connector design and termination technique shall be independent of cable type or manufacturer and shall be compatible for either 900-micron buffer or 250-micron buffer distribution cables.
19. LC connector strain relief boot shall be a Telcordia style slotted design for maximum flexural strain relief.
20. Strain relief boot shall be black for multimode, and yellow for singlemode.
21. LC connectors shall be available individually bagged in packs of 12.
22. Pre-polished LC fiber connectors, when properly installed onto qualified cable, shall meet the 10 Gb/s Ethernet performance requirements of IEEE802.3.

23. Pre-polished LC fiber connectors, properly installed onto qualified cable, shall exceed the mechanical and environmental performance requirements of ANSI/TIA/EIA-568-C.3, Annex 'A'.
24. Pre-polished LC fiber connectors, properly installed onto qualified cable, shall exceed the mechanical and environmental performance requirements of Telcordia GR-1081-CORE.
25. Qualification test data shall be available from the manufacturer upon request.

2.4 SINGLE MODE FIBER OPTIC CABLES

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Corning
 5. Belden
 6. Berk-Tek, Inc.
- B. Basis of Design – Hubbell Premise Wiring HFCD19 Series Indoor/Outdoor Fiber Optic Cable
- C. Optical Fiber Indoor/Outdoor Distribution Cable, Cable Requirements
 1. Optical Fiber Indoor/Outdoor Distribution Cable shall be constructed with 12 optical fibers unless otherwise noted on the Drawings, each coated with a 900-micron color-coded PVC tight buffer, surrounded by an aramid yarn strength member, and an armored outer jacket with the appropriate flame rating.
 2. Fiber cables shall be a non-metallic construction, OFNP (Plenum FT-6) flame rating.
 3. Cable markings shall repeat every meter, and shall have at minimum the following information:
 - a. Sequential length indicator marking (meters)
 - b. Lot number, traceable back to the fiber draw lot
 - c. Date of Manufacture
 - d. Fiber type: (Singlemode)
 - e. Cable rating (OFNR, OFNP, etc.)
 - f. Applicable Telcordia, TIA, IEC, and ICEA standard references and appropriate UL/CSA agency listings
 4. Cable jacket colors shall conform to the following industry standard conventions:
 - a. Yellow: Singlemode
 5. Buffer position color codes shall conform to standard ICEA and TIA-598 conventions as follows: 1-Blue, 2-Orange, 3-Green, 4-Brown, 5-Slate, 6-White, 7-Red, 9-Yellow, 10-Violet, 12-Aqua.
 6. Optical fiber in any cable construction shall be enhanced performance, bend-insensitive type.
 7. Singlemode cables shall perform at minimum to the attenuation, bandwidth, and distance application parameters in the table below.

Singlemode Fiber Gigabit and 10 Gigabit Ethernet Application Chart					
Application	Wavelength (nm)	Max Attenuation (dB/km)	Bandwidth (MHz•Km)	1 GbE Distance (m)	10 GbE Distance (m)

1000BASE-LX	1310	0.35	> 1000	5000	n/a
10GBASE-L	1310	0.35	> 1000	n/a	10,000
10GBASE-E	1550	0.25	> 1000	n/a	40,000
10GBASE-LX4	1310	0.35	> 1000	n/a	10,000

8. Optical fiber cables as supplied shall meet or exceed the applicable IEC 60793-1 qualification test requirements for optical, geometry, mechanical, and environmental parameters as specified, and tested in accordance with TIA/EIA-455.
9. For installed fiber cables, all fiber strands shall pass insertion loss and return loss in accordance with test methods ANSI/TIA/EIA-526-14 for multimode cables.
10. Installed fiber cables shall exceed all currently ratified bandwidth-distance- application performance parameters for IEEE 802.3ae (10 GbE) and for IEEE 802.3ba (40/100 GbE)
11. Plenum cables shall be rated UL NFPA-262/UL910/CSA FT-6

- D. Provide combination multimode/single mode cables when indicated.
- E. All fibers shall be terminated in Fiber Connectors with LC or SC connectors as required to match patch panels. Re-terminate existing fiber optic cables as required to make compatible with new patch bays.

2.5 SINGLE MODE FIBER OPTIC PATCH CORDS

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring DFHPCLCL (SM) Series patch cords.
- C. Fiber optic cable shall be terminated with LC OS2 Singlemode connectors to fiber adapter panels mounted in Hubbell FCR series fiber optic enclosures with at least 50% spare capacity.
- D. Design Requirements
 1. LC duplex optical fiber patch cords shall be constructed with aramid-reinforced PVC loose-jacket duplex cable, with optical fibers having a 900-micron PVC buffer coating diameter.
 2. Single Mode OS2 core optical fiber within the patch cord cable shall be graded index type in accordance with ANSI/TIA/EIA-492AAAC, with the following specifications:
 - a. Core diameter: 9 ± 1.0 microns
 - b. Cladding diameter: 125 ± 2.0 microns
 - c. Core/cladding concentricity: less than 3.0 microns
 - d. Core non-circularity: 6% maximum
 - e. Proof test: 100 kpsi
 - f. Effective modal bandwidth: 2000 MHz•km
 - g. Coating diameter: 245 ± 15 microns
 - h. Buffer diameter: 900 microns nominal
 3. Connector terminations on each end of the fiber patch cord shall be heat-cured epoxy type with a machine polish, inspected 100% for polish quality and mated-pair insertion loss.

4. Epoxy volume within each connector shall be sufficient to properly surround and strain relieve the fiber and buffer layer at the buffer/fiber transition inside the connector body.
 5. Optical fiber patch cords shall be supplied in a sealed plastic bag with dust caps installed on each end, with insertion loss test results included.
 6. Optical fiber patch cords shall be available in standard lengths of 1, 2, 3, and 5 meters. Special lengths shall be available on a make-to-order basis.
 7. Optical fiber patch cords shall be manufactured with industry standard LC connector terminations on each end.
 8. Factory mounted connectors on each end of the patch cords shall comply with the applicable ANSI/TIA/EIA-604 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 Singlemode OS2 laser optimized multimode fiber cables.
 - a. Fiber patch cord connector materials shall be as follows:
 - b. Ferrules: zirconium ceramic
 - c. Housings: injection molded thermoplastic
 - d. Dust Cap: nylon or PVC
 - e. Strain relief boot: UL94-V0 molded PVC
 17. SingleMode OS2 laser optimized patch cords shall have a maximum mated-pair insertion loss of 0.60 dB per end, with a minimum return loss of -20 dB.
 18. Fiber patch cords shall exceed 10 Gigabit Ethernet performance requirements of IEEE 802.3 standard.
 19. Fiber patch cords shall exceed the mechanical reliability requirements for tensile, flex, twist and impact as specified in ANSI/TIA/EIA-568-C.3
 20. Fiber patch cords shall exceed the environmental reliability requirements for high/low temperature and humidity as specified in ANSI/TIA/EIA-568-C.3
- E. Provide one patch cable for every connected patch panel port. Provide length as required to terminate between fiber patch panels/outlets and equipment in a neat and workmanlike manner through cable management assemblies.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install all cables in accordance with equipment manufacturer's instructions, and with recognized industry practices, to ensure the installation complies with requirements of the NEC, ANSI/TIA/EIA-568-C.1 Commercial Building Telecommunications Cabling Standard and BICSI'S "Telecommunication Distribution Methods Manual" (current edition).
- B. Install all cables only when the temperature is between 32°F to 122°F.
- C. Wiring Method: Wiring shall be installed in EMT conduit within walls and above inaccessible ceilings. Wiring shall be installed in cable tray where it is present. Wiring installed above accessible ceilings between ceiling mounted devices or conduit stub-ups and the cable tray shall be exposed and supported by J-hooks, spaced a maximum of 5'-0" on center, with minimum 1" flat bearing surface. Provide conduit sleeves, bushings and fireproofing through all wall penetrations. All wiring not in EMT conduit shall be kept a minimum of 6" away from all lighting fixtures, motors, and transformers. Cables cannot be ty-wrapped or stapled to ceiling or structural supports, conduit, or other items.
- D. Test each cable as detailed in specification. Include patch cord in test channel.
- E. Identify all cables with a neatly typed label as detailed in specification.
- F. Provide horizontal and vertical cable management in all racks, on all backboards and any other location cabling is not routed in conduit or cable tray. Size cable management for 50% additional cables.
- G. For buildings with floors in excess of two, provide a 2' diameter service loop (with 3 loops) in all between-floor fiber optic cables. Locate one service loop in ceiling cavities of each floor above the lowest floor for future changes/upgrades. Neatly cable tie service loop to structure or cable tray to prevent susceptibility to damage.
- H. Install cable without damaging conductors, shield, or jacket, do not use unjacketed pairs for jumpers.
- I. Do not bend cable in handling or in installing to smaller radii than minimums recommended by manufacturer.

- J. No splicing is permitted for fiber optic cables or telephone high pair count cables. Cables must be continuous between termination points. Make splices, taps and terminations only at indicated outlets, terminals, cross-connect and patch panels.
- K. Provide at least 10' of cable slack at MDF or IDF closet. This slack may be stored in the cable tray or a cable management device behind the MDF/IDF.
- L. Provide 2' diameter in service loops or use figure-8 or serpentine.
- M. Pull cables without exceeding cable manufacturers recommended pulling tensions.
 - 1. Pull cables simultaneously if more than one is being installed in the same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway.
- N. Install exposed cable parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.
- 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 271500 – COMMUNICATIONS HORIZONTAL CABLING – CATEGORY 6

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. UTP Cables and Equipment
- B. Modular Jacks, Modules and Faceplates
- C. Surface Mount Boxes
- D. 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 6 UTP RACK MOUNT PATCH PANELS FOR DATA

- A. Manufacturers:
 - 1. Hubbell Premise Wiring
 - 2. The Siemon Company – Z-Max Series
 - 3. Systimax GigaSpeed Products – XL Series
 - 4. Leviton – 69586 Series
- B. Basis of Design – Hubbell Premise Wiring HP624/HP648 Series category 6 patch panels
- C. Design Requirements:
 - 1. Category 6 patch panels shall be standard 8-position, RJ-45 style, un-keyed, FCC and IEC 60603-7 compliant receptacle, in 24- and 48-port configurations. 96-Port will not be acceptable.
 - 2. Panel frames shall be black powder coated 14-ga steel with rolled edges top and bottom for proper stiffness.
 - 3. Panels shall accommodate a minimum of 24 ports for each rack mount unit (1 RMU = 1.75").
 - 4. Panels shall be designed for 4-pair, 100-ohm balanced unshielded twisted pair (UTP) cable.
 - 5. Panels shall terminate 26-22 AWG solid conductors, with maximum insulation diameter of 0.050".
 - 6. Panels shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.
 - 7. Panels shall have individual port identification numbers on the front and rear of the panel.
 - 8. Panels shall utilize 6-port adapter modules, each secured with one screw. Adapter module housings shall be UL 94 V-0 rated thermoplastic.
 - 9. Panel adapter modules shall be 110-style termination with lead free tin solder plated IDC contacts.
 - 10. Printed circuit boards shall be fully enclosed front and rear for physical protection.

11. Panel contacts shall withstand a minimum of 2000 mating cycles with an FCC 8-position RJ-45 plug, without degradation of electrical or mechanical performance.
12. Panel contacts shall be constructed of Beryllium copper for maximum spring force and durability.
13. Panel receptacle contacts shall be arranged in-line on the PC board with pins in 1-2, 4-5, and 7-8 formed with a cross over feature to provide improved near end cross talk (NEXT).
14. Contact plating shall be a minimum of 45 micro-inches of precious metal in the contact area over 50 micro-inch of nickel.
15. Panel receptacle contact shall also make contact with secondary PCB to provide improved RF compensation while keeping contacts as sort as possible.
16. IDC contacts shall be arranged in-line.
17. Panels shall have the C6 designation, visible from the front when installed.
18. Panels shall utilize a paired punch-down sequence to maximize electrical performance.
19. Panel termination method shall follow the industry standard 110 IDC punch-down, using a standard 110 impact termination tool.
20. Rear IDC contacts shall be Phosphor Bronze with 100 micro-inch lead free tin plating over nickel.
21. HP6 series panel adapter ports shall accept optional hinged dust covers.
22. HP6 series panel adapter ports shall accept snap-on icons for specific identification.
23. Space above the adapter ports shall be available for additional labeling per ANSI/TIA/EIA-606-A.
24. Category 6 panels shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.
25. Panels shall accept a clip-on rear cable management support bar to provide cable strain relief.
26. Panels shall include integrated label holders with white designation labels and a clear cover for each 6-port adapter.
27. Panel adapters shall accept strain relieving stuffer caps, one cap per port.
28. Panels shall be manufactured in the USA.

D. Performance Requirements:

1. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
2. Category 6 panels shall meet or exceed Category 6 transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-C.2, Transmission Performance Specifications for 4-Pair 100-ohm Category 6 Cabling.
3. The manufacturer shall provide Category 6 component compliance certificates from third party testing organizations upon request.
4. Panels shall be UL LISTED 1863 and CSA certified.
5. Panels shall exceed IEEE 802.3bt DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
6. Panel contacts shall withstand a minimum of 2000 mating cycles with an FCC 8-position RJ-45 plug, without degradation of electrical or mechanical performance.
7. Panels shall be third party verified, error free Gigabit Ethernet performance to IEEE 802.3 standard.
8. Category 6 panels shall exceed 4 Gb/s data transmission capacity within the bandwidth of 1 – 250 MHz when configured in a 4-connector channel.

9. Category 6 panels shall meet or exceed the 4-connector channel performance requirements of Category 6, per the ANSI/TIA/EIA-568-C.2 standard.
10. The 4-connector channel test configuration shall utilize Category 6 patch panels, Category 6 jack, and Category 6 patch cords, from the same manufacturer, with qualified Category 6 cable.
11. The 4-connector channel performance margins in the table below shall be guaranteed. Conditions of requirement No. 10 above apply.
12. Category 6 panels shall meet the current draft 10 Gb/s performance requirements of IEEE 802.3 and TSB-155, for a maximum 55-meter channel length. Conditions of requirement No. 10 above apply.

Electrical Parameter (1 - 250MHz)	Guaranteed Margins to Category 6 / Class E Channel Specifications
Insertion Loss	3 %
NEXT	4 dB
PSNEXT	5 dB
ELFEXT	4 dB
PSELFEXT	5 dB
Return Loss	2 dB

- E. Provide patch panel port quantity as required for cables + 20% spare unless otherwise noted on the drawings.

2.2 CATEGORY 6 UTP CABLES FOR DATA

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company – 9C6P4-E3-(06)-RBA Series
 3. Systemax GigaSpeed Products –2071E Series (700208093)
 4. Berk-Tek, Inc. – 10032093 Series
- B. Basis of Design – Hubbell Premise Wiring HC6RPB Category 6 – 550MHz Plenum
- C. Design requirements
 1. Cable construction shall be four twisted pairs of 23 AWG insulated solid conductors, with a ripcord, surrounded by a tight outer jacket.
 2. Cable shall be manufactured with an “X”-shaped pair-divider along the center to maintain separation of individual pairs.
 3. Conductor diameters shall be 0.0224" ± .0003" solid copper.
 4. Conductor insulation diameter shall be 0.039" ± .0005" fluoro copolymer.
 5. Twist lay of each pair shall vary in a manner to optimize noise immunity and minimize crosstalk.
 6. Outer jacket diameter shall be 0.235" ± .008" low smoke PVC, with a nominal wall thickness of 0.015".
 7. Ripcord shall be directly underneath the outer jacket.
 8. Cable shall be marked: “HUBBELL NEXTSPEED CATEGORY 6 Mid-Grade – AAAAAA - PLENUM - 4PR 23AWG C(UL)US CMP E255553 – VERIFIED (UL) CAT6 ANSI/TIA 568-C.2 - Z/YY (XXXX) – R#”.

- a. Frequency of marking shall be every 2.0'.
 - b. 'Z' represents the month of manufacture.
 - c. 'YY' indicates the year of manufacture.
 - d. 'XXXX' indicates the job number.
 - e. 'NNNN' indicates the sequential footage markers.
 9. UL, ETL, or CSA agency certification or verification markings shall be marked on the cable jacket according to the certifying agency's requirements.
 10. Color coding of the pairs shall be as follows:
 - a. Pair 1: White/Blue; Blue
 - b. Pair 2: White/Orange; Orange
 - c. Pair 3: White/Green; Green
 - d. Pair 4: White/Brown; Brown
 11. Cable shall be supplied in 1000' spools.
- D. Performance Requirements:
1. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
 2. Cable shall exceed Category 6 transmission requirements specified in ANSI/TIA/EIA-568-C.2-1 and shall be tested through 550 MHz.
 3. Cable shall exceed the requirements of TIA/TSB-155: 10 Gb/s Ethernet Operation over 55 Meters Channel Length.
 4. Worst-case cable performance shall be +8.0 dB headroom over current TIA/EIA and ISO standards limits for NEXT and PSNEXT loss, and ELFEXT and PSELFEXT loss.
 5. Insertion loss shall be 3.0% lower than standard Hubbell Category 6 plenum and riser cables.
 6. Worst case electrical performance characteristics shall be as follows:
 - a. Characteristic Impedance: 100 ± 15 ohms (1.0-100 MHz) 100 ± 20 ohms (101-250 MHz)
 - b. Maximum Conductor Resistance: 9.38 ohms /100 Meters @ 20°C
 - c. Maximum Resistance Unbalance: 3%
 - d. Maximum Mutual Capacitance: 5.6 nF/100 Meters @ 1 kHz
 - e. Maximum Capacitance Unbalance: 330 pF/100 Meters
 - f. Maximum Delay Skew: 35 ns/100 Meters
 7. The manufacturer shall provide Category 6 component compliance certificates from third party testing organization upon request.
 8. Cable shall be UL and c (UL) listed.
 9. Cable shall exceed IEEE 802.3bt DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
 10. Cable shall be third party verified, error free Gigabit Ethernet performance to IEEE 802.3 standard.
 11. Cable shall meet or exceed the 4-connector channel performance requirements of Category 6, per the ANSI/TIA/EIA-568-C.2-1 standard.
 12. The 4-connector channel test configuration shall utilize Category 6 jacks and patch panels, with Category 6 patch cords, from the same manufacturer, with qualified Category 6 cable.
 13. The 4-connector channel performance margins in the table below shall be guaranteed provided the configuration satisfies requirement No. 12 above.

Electrical Parameter (1 - 250MHz)	Guaranteed Margins to Category 6 / Class E Channel Specifications
Insertion Loss	3 %
NEXT	4 dB
PSNEXT	5 dB
ACR-F	6 dB
PSACR-F	7 dB
Return Loss	4 dB

2.3 CATEGORY 6 INDOOR/OUTDOOR UTP CABLES

- A. Manufacturers:
 - 1. Hubbell Premise Wiring
 - 2. The Siemon Company
 - 3. Systemax GigaSpeed Products
 - 4. Berk-Tek, Inc.
- B. Basis of Design: Hubbell Premise Wiring C6I0SPBK
- C. Usage:
 - 1. Slab on grade conduit runs to floorboxes or outlet boxes.
 - 2. Exterior conduit to handholes or other locations.
- D. Design Requirements:
 - 1. Cable construction shall be four twisted pairs of 23-ga insulated solid copper conductors, cabled around a cross web separator, and surrounded by an overall jacket.
 - 2. Cable shall be gel free and use specialty jacket materials or barriers to protect against water ingress.
 - 3. Jacket color shall be black, and material shall be UV resistant.
- E. Performance Requirements:
 - 1. Cable shall meet or exceed Category 6 transmission requirements specified in TIA-568.2D (current revision), for all electrical characteristics.
 - 2. Cable shall meet or exceed permanent link and 4-connector channel performance requirements specified in ANSI/TIA 568 (current revision) standard.
 - 3. UL Listed Type CMP
 - 4. Cable shall be rated for an operating temperature range of -40°F to 167°F (-40°C to 75°C)

2.4 CATEGORY 6 UTP PATCH CABLES FOR DATA

- A. Manufacturers:
 - 1. Hubbell Premise Wiring
 - 2. The Siemon Company
 - 3. Systimax GigaSpeed Products
 - 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring HCL6 Low OD Series category 6 patch cords

C. Design Requirements:

1. Category 6 patch cords shall be constructed with a clear polycarbonate plug and boot having vertically staggered, trifurcated contacts, each having 50 micro-inches of gold plating.
2. Plug dimensions and function shall comply with FCC 47, Part 68.5.
3. Patch cords shall have a snag-less feature, integral to the strain relief boot on each end.
4. Patch cords shall be constructed with category 6 patch cable, with 24 AWG 7/32 tinned copper stranded conductors, each insulated with polyethylene, and overall jacket with UL flame-retardant PVC.
5. Patch cords shall be manufactured using a T568B wiring format and shall function suitably for either T568A or T568B wiring schemes.
6. Patch cords shall be available in the following colors: black, blue, gray, yellow, orange, red, green, white, and purple. Custom lengths and colors shall be available with a delivery lead-time quotation.
7. Standard patch cord lengths shall range from 3' to 20'.
8. Category 6 patch cords shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.

D. Performance Requirements:

1. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
2. Category 6 patch cords shall be channel performance balanced with Hubbell category 6 jacks, patch panels, and punch-down blocks.
3. Category 6 patch cords shall meet or exceed Category 6 component transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-C.2 standard.
4. The manufacturer shall provide Category 6 component compliance certificates from third party testing organization upon request.
5. Patch cords shall be cUL and UL LISTED 1863.
6. Patch cords shall exceed IEEE 802.3bt DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
7. Patch cords shall be third party verified, error-free Gigabit Ethernet performance to IEEE 802.3 standard.
8. Jacks shall exceed 4 Gb/s data transmission capacity within the bandwidth of 1 – 250 MHz when configured in a 4-connector channel.
9. Category 6 patch cords shall meet or exceed the 4-connector channel transmission performance requirements of Category 6, per ANSI/TIA/EIA-568-C.2 standard.
10. The 4-connector channel test configuration shall utilize Category 6 patch panels, blocks, and jacks, with Category 6 patch cords, all from the same manufacturer, with qualified Category 6E cable.
11. The 4-connector channel performance margins in the table below shall be guaranteed, provided the configuration satisfies requirement No. 10 above.
12. Category 6 patch cords shall meet the current draft 10 Gb/s transmission performance requirements of TSB-155, provided the configuration satisfies requirement No. 9 above.

ELECTRICAL PARAMETER (1 – 250 MHZ)	GUARANTEED MARGINS TO CATEGORY 6 / CLASS E CHANNEL SPECIFICATIONS
Insertion Loss	3 %
NEXT	4 dB

PSNEXT	5 dB
ACR-F	6 dB
PSACR-F	7 dB
Return Loss	4 dB

- E. Provide two patch cables for every connected patch panel ports. Provide length as required to terminate between fiber patch panels/outlets and equipment in a neat and workmanlike manner through cable management assemblies.

2.5 TELEPHONE CABLES

- A. Telephone Workstation Cable: Provide UTP patch cables to match those used for data.

2.6 CATEGORY 6 MODULAR JACKS

- A. Manufacturers:
1. Hubbell Premise Wiring
 2. The Siemon Company – Z-Max Series
 3. Systimax GigaSpeed Products – X10 Series
 4. Leviton – 61110-RW6
- B. Basis of Design – Hubbell Premise Wiring HXJ6 or HJU6 (Cobra-Lock Style) Series category 6 jacks
- C. Design Requirements:
1. Jacks shall be standard 8-position, RJ-45 style, un-keyed, FCC compliant.
 2. Jacks shall be designed for 4-pair, 100-ohm balanced unshielded twisted pair (UTP) cable.
 3. Each jack shall be single unit construction, with snap – fit to industry standard keystone opening (.760" x .580").
 4. Jack housings shall be high impact UL 94 V-0 rated thermoplastic.
 5. Jacks shall have a temperature rating of -10°C (14°F) to 70°C (158 °F).
 6. Jack housings shall fully encase and protect printed circuit boards and IDC fields.
 7. Modular jack contacts shall accept a minimum of 2000 mating cycles without degradation of electrical or mechanical performance.
 8. Jack contacts shall maintain a minimum deflection force of 100 grams while mated with an FCC-standard RJ-45 plug.
 9. Jack contacts shall be constructed of Beryllium copper for maximum spring force and durability.
 10. IDC contacts shall be Phosphor Bronze with 100 micro-inch tin lead 60/40 plating over nickel.
 11. Jacks shall terminate 26-22 AWG solid or stranded conductors.
 12. Jacks shall terminate insulated conductors with outside diameters up to .050".
 13. Jacks shall not require special cords, specialty tools or special installation requirements.
 14. Jacks shall be compatible with single conductor standard 110 impact termination tools.
 15. Jacks shall be compatible with a 4-pair single punch impact tool designed specifically for the purpose.
 16. Jacks shall include a translucent stuffer cap for wire retention and to permit visual inspection.

17. Stuffer cap shall have retention snaps to assure conductor strain relief.
18. Jacks shall accept FCC compliant 6 position plugs.
19. Jacks shall accept optional hinged dust covers.
20. Jacks shall be compatible with ANSI/TIA/EIA-606-A color code labeling.
21. Jacks shall accept snap-on icons for specific identification.
22. Jacks shall be available in various colors to meet specific customer applications.
23. Jacks shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.
24. Category 6 jacks shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.

D. Performance Requirements:

1. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
2. Category 6 jacks shall exceed Category 6 transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-C.2, Transmission Performance Specifications for 4-Pair 100-ohm Category 6 Cabling.
3. Category 6 jacks shall exceed 10 Gb/s transmission requirements for connecting hardware, under the constraints of ANSI/TIA-TSB-155 (current draft).
4. The manufacturer shall provide Category 6 component compliance certificates from third party testing organization upon request.
5. Jacks shall be UL LISTED 1863 and CSA certified.
6. Jacks shall exceed IEEE 802.3bt DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
7. Jacks shall be third party verified, error free Gigabit Ethernet performance to IEEE 802.3 standard.
8. Jacks shall exceed 4 Gb/s data transmission capacity within the bandwidth of 1 – 250 MHz when configured in a 4-connector channel.
9. Jacks shall exceed the 4-connector channel performance requirements of Category 6, per the ANSI/TIA/EIA-568-C.2 standard.
10. Jacks shall exceed the 4-connector Category channel performance requirements for 10 Gb/s transmission over Category 6, according to TIA/TSB-155 (current draft).
11. The 4-connector channel test configuration shall utilize Category 6 patch panels and Category 6 patch cords, from the same manufacturer, with qualified Category 6E cable.
12. The 4-connector Category 6 channel performance margins in the table below shall be guaranteed, provided the configuration satisfies requirement No. 11 above.

Electrical Parameter (1 - 250MHz)	Guaranteed Margins to Category 6 / Class E Channel Specifications
Insertion Loss	3 %
NEXT	4 dB
PSNEXT	5 dB
ACR-F	6 dB
PSACR-F	7 dB
Return Loss	4 dB

2.7 STAINLESS STEEL FACE PLATES AND UNLOADED MODULES

- A. Manufacturers:
 - 1. Hubbell Premise Wiring
 - 2. The Siemon Company
 - 3. Systimax GigaSpeed Products
 - 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring IMSS Series Modular Faceplates and Modules.
- C. Design Requirements:
 - 1. IMSS Series Faceplates:
 - a. Faceplates shall be constructed of Stainless Steel.
 - b. Faceplates shall be 2.75" W x 4.5" H for single gang and 4.5" X 4.5" for double gang.
 - c. Faceplates shall accept modules loaded with Hubbell HXJ-series series jacks and Hubbell Snap-Fit fiber optic, audio, and video connectors for multimedia applications.
 - d. Two #6-32 pan head Phillips/slotted mounting screws shall be included with each single gang faceplate.
 - e. Four #6-32 pan head Phillips/slotted mounting screws shall be included with each double gang faceplate.
 - f. Faceplates shall be compatible with standard NEMA openings and boxes.
 - g. Faceplates shall be compatible with raceway fittings, surface mount boxes, service fittings, service poles, flush mount boxes and drywall rings.
 - 2. IMSS Series Modules:
 - a. Faceplate Modules shall be constructed of high impact, UL94 V-0 rated thermoplastic.
 - b. Modules shall be compatible with IMSS Series Faceplates, raceway, floor boxes, poke throughs, surface mount boxes, patch panels, furniture plates, and service poles.
 - c. Modules shall snap firmly into front of faceplate and position flush to outer plate surface for field installation in any of the specified mounting hardware devices and media configurations.
 - d. Single gang IMSS Series Faceplate shall accept (3) 1U modules
 - e. Double Gang IMSS Series Faceplate shall accept (6) 1U modules.
 - f. 1 Unit Modules shall be available for 1- and 2-Port Keystones, Blanks, and punched blanks to support the following connections per work area requirements.
 - 1) RJ-45 Category 6 jack per ANSI/TIA/EIA-568-C.2
 - 2) RJ-45 Category 6A jack per ANSI/TIA/EIA-568-C.2
 - 3) ST fiber optic connector per EIA/TIA-604-3
 - 4) SC fiber optic connector per EIA/TIA-604-3
 - 5) LC fiber optic connector per EIA/TIA-604-3
 - 6) S-Video Gold Jack
 - 7) RCA Gold Jack (color coded)
 - 8) BNC connector (straight mount)
 - 9) Gold F connector (straight mount)
 - 10) SVGA (female)
 - 11) 3.5 Mini Stereo Jack
 - 12) Gold Speaker Post

- 13) HDMI connector
- 14) USB connector
- 15) Blank filler plate

2.8 CATEGORY 6 PLENUM SURFACE MOUNT BOX 2-PORT

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring HSB2EIP (Plenum Rated) with HXJ6 Series category 6 jacks
- C. Application – Wireless Access Points, IP cameras and other remote IP devices.
- D. Design Requirements:
 1. Box material shall be constructed from high impact thermoplastic; UL 94-V0.
 2. Box shall be suitable for use in other environmental air space in accordance with Section 300.22 of the National Electric Code.
 3. Box shall be tested for UL 2043.
 4. Box shall meet the requirements of UL 1863 modules and frames.
 5. Box shall be RoHS compliant.
- E. Performance Requirements:
 1. Box shall be suitable for air handling spaces.
 2. Box shall have a low-profile design.
 3. Box shall accept Hubbell HJ and HXJ jacks and audio/video keystone connectors.
 4. Box shall have easy cover latches to provide flexibility for simple moves, adds and changes.
 5. Box shall have a secure, tamper resistant screw.

2.9 FIELD-TERMINATED PLUG, CATEGORY 6

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring SP6 or SP690 (Right Angled) or Coupler Assembly SCP6Axxyy (18", 3', 5', 7', 10')
- C. Application – Wireless Access Points, IP cameras and other remote IP devices.
- D. Design Requirements:
 1. The plug shall meet the following criteria:
 2. Meet or exceed all requirements for Category 6 as described in ANSI/TIA-568-C.2.

3. Compliant with ANSI/TIA-1096-A.
4. Accommodate T568A/B wiring schemes.
5. Accommodate 26-22 AWG shielded or unshielded, solid or stranded conductors.
6. Support Power over Ethernet (PoE) up to 100 watts.
7. Connector body constructed of die-cast zinc
8. Suitable for plenum areas.
9. UL listed.

2.10 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 SP10GR
- 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, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install all cables in accordance with equipment manufacturer's instructions, and with recognized industry practices, to ensure the installation complies with requirements of the NEC, ANSI/TIA/EIA-568-C.1 Commercial Building Telecommunications Cabling Standard and BICSI'S "Telecommunication Distribution Methods Manual" (current edition).
- B. Install all cables only when the temperature is between 32°F to 122°F.
- C. Wiring Method: Wiring shall be installed in EMT conduit within walls and above inaccessible ceilings. Wiring shall be installed in cable tray where it is present. Wiring installed above accessible ceilings between ceiling mounted devices or conduit stub-ups and the cable tray shall be exposed and supported by J-hooks, spaced a maximum of 5'-0" on center, with minimum 1" flat bearing surface. Provide conduit sleeves, bushings and fireproofing through all wall penetrations. All wiring not in EMT conduit shall be kept a minimum of 6" away from all lighting fixtures, motors, and transformers. Cables cannot be ty-wrapped or stapled to ceiling or structural supports, conduit, or other items.
- D. Test each cable as detailed in specification. Include patch cord in test channel.
- E. Identify all cables with a neatly typed label as detailed in specification.
- F. Provide horizontal and vertical cable management in all racks, on all backboards and any other location cabling is not routed in conduit or cable tray. Size cable management for 50% additional cables.
- G. UTP Cable Length:

1. Maximum installed length of each UTP cable between closet and workstation outlet is to be 90 meters (295'). Ensure lengths are within specification prior to installation. Contact Engineer for procedure in the event of excessive distances prior to installation.
 2. Minimum length shall be 15 meters (49'). Provide service loop as required to increase length on short runs.
- H. Install cable without damaging conductors, shield or jacket, do not use unjacketed pairs for jumpers.
- I. Do not bend cable in handling or in installing to smaller radii than minimums recommended by manufacturer.
- J. No splicing is permitted for UTP cables. Cables must be continuous between termination points. Make splices, taps and terminations only at indicated outlets, terminals, cross-connect and patch panels.
- K. Provide at least 10' of cable slack at MDF or IDF closet. This slack may be stored in the cable tray or a cable management device behind the MDF/IDF.
- L. Provide 2' diameter in service loops or use figure-8 or serpentine.
- M. Provide at least 1' of slack at each workstation outlet. This slack may be coiled within device box observing bend radius minimum or within accessible ceiling space using approved J-hook support.
- N. Remove jacket of cable and untwist individual UTP conductors the minimum amounts required to terminate on jacks and patch panels.
- O. Category 6 cable fill in conduit is 40% maximum as follows:
1. 3/4" - 4 UTP Cables
 2. 1" - 6 UTP Cables
 3. 1-1/4" - 12 UTP Cables
 4. 1-1/2" - 16 UTP Cables
 5. 2" - 22 UTP Cables
 6. 2-1/2" - 36 UTP Cables
 7. 3" - 50 UTP Cables
 8. 3-1/2" - Not recommended
 9. 4" - Not recommended
 10. Provide larger conduits than recommended for cable fill if indicated on the Drawings.
- P. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
1. Pull cables simultaneously if more than one is being installed in the same raceway.
 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway.
- Q. Secure and support cable at intervals not exceeding 5'-0" and not more than 1'-0" from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

- R. Wiring within IDF/MDF and Enclosures: Provide adequate length of conductors. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- S. Separation of Wires: Comply with EIA/TIA-569 rules for separating unshielded copper telecommunications equipment cables from potential EMI sources, including electrical power lines and equipment.
- T. Support raceways, cabinets, and all other equipment in accordance with manufacturer's instructions.

3.3 LABELING

- A. System: Use a unique, 3 syllable alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
 - 1. First syllable identifies and locates wiring closet or equipment room where cable originates.
 - 2. Second syllable identifies and locates cross-connect or patch-panel field in which cable terminates.
 - 3. Third syllable designates type of media (copper or fiber) and position occupied by cable pairs or fibers in the field.
 - 4. Example: A2-2-C46
- B. Workstation: Label cables within outlet boxes.
- C. Within Connector Fields, in IDF/MDF Rooms and Consolidation Points: Label each connector and each discrete unit of cable terminating and connecting hardware. Where similar jacks and plugs are used for both communication and data-processing equipment, use a different color for jacks and plugs of each service.
- D. Cables, General: Label each cable within 4" of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
- E. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 100 feet.
- F. Cable Schedule: Post in prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Provide electronic copy of final comprehensive schedules for project, in software and format selected by Owner.

3.4 GROUNDING

- A. Comply with Section 260526 and applicable details on plans.

- B. Provide connections to the main ground bus on all backboards, telephone line protectors, IDF Racks and MDF Racks in the project. Connect to ground buses with cables per Specification Section 260526 and applicable details on plans.

3.5 FINAL TESTING AND INSPECTION

- A. Provide testing in accordance with ANSI/TIA/EIA-568-C.1.
- B. Cable Test: Provide prior to substantial completion, a Performance Evaluation Report, which will contain the following:
 - 1. Cable Test: List by cable number each UTP Cable in the project, which details:
 - a. UTP Cables:
 - 1) Cable ID Number
 - 2) List continuity, reversal, open, shorts and miswires
 - 3) Category performance
 - 4) List other discrepancies with the UTP installation (bad terminations, faulty labeling, etc).
 - 5) Tester printout for each cable.
 - 2. UTP Cable Testing: Test each cable pair of each cable after installation for Specified Category performance. Conduct test with a tester designed for testing above cable (with RJ-45 jacks installed) from each data outlet to associated patch cord through +0 panel jack (Channel). Provide printout for each test as part of the Performance Evaluation Report. Minimum performance categories for report are to be as follows:
 - a. Wire Map/Continuity
 - b. Length
 - c. Near End Crosstalk (pair to pair) NEXT
 - d. Near End Crosstalk (power sum) PSNEXT
 - e. Equal Level Far-End Crosstalk Loss (pair to pair) ELFEXT
 - f. Equal Level Far-End Crosstalk Loss (power sum) PSELFEXT
 - g. Return Loss
 - h. Attenuation
 - i. Propagation Delay
 - j. Delay Skew
 - k. PSACR (Powersum Attenuation – Crosstalk Ratio)
 - 3. System Performance Report: Provide a narrative detailing the system as a whole, in regard to the quality of installation and any discrepancies affecting performance. This narrative to indicate a summary of the above Cable Test, as well as an accurate summary of specified Category performance as well as capability of the cabling system to perform at specified Category bandwidth.

3.6 WARRANTY

- A. The installation shall be provided with a minimum 25-year warranty for strict compliance with the performance requirements of ANSI/TIA/EIA-568-C.1 to support and conform to ANSI/TIA/EIA-568-C.1 specifications covering any current or future application which supports transmission over a properly constructed horizontal cabling system premises network which meets the channel performance as described in ANSI/TIA/EIA-568-C.2.

END OF SECTION 271500

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. 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 C6ASPDsxx Category 6A - Plenum
- 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 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 HCL6A Low OD 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.

2.4 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

2.5 STAINLESS STEEL FACE PLATES AND UNLOADED MODULES

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring IMSS Series Modular Faceplates and Modules.
- C. Design Requirements:
 1. IMSS Series Faceplates:
 - a. Faceplates shall be constructed of Stainless Steel.
 - b. Faceplates shall be 2.75" W x 4.5" H for single gang and 4.5" X 4.5" for double gang.
 - c. Faceplates shall accept modules loaded with Hubbell HXJ-series series jacks and Hubbell Snap-Fit fiber optic, audio, and video connectors for multimedia applications.
 - d. Two #6-32 pan head Phillips/slotted mounting screws shall be included with each single gang faceplate.
 - e. Four #6-32 pan head Phillips/slotted mounting screws shall be included with each double gang faceplate.
 - f. Faceplates shall be compatible with standard NEMA openings and boxes.
 - g. Faceplates shall be compatible with raceway fittings, surface mount boxes, service fittings, service poles, flush mount boxes and drywall rings.
 2. IMSS Series Modules:
 - a. Faceplate Modules shall be constructed of high impact, UL94 V-0 rated thermoplastic.

- b. Modules shall be compatible with IMSS Series Faceplates, raceway, floor boxes, poke throughs, surface mount boxes, patch panels, furniture plates, and service poles.
- c. Modules shall snap firmly into front of faceplate and position flush to outer plate surface for field installation in any of the specified mounting hardware devices and media configurations.
- d. Single gang IMSS Series Faceplate shall accept (3) 1U modules
- e. Double Gang IMSS Series Faceplate shall accept (6) 1U modules.
- f. 1 Unit Modules shall be available for 1- and 2-Port Keystones, Blanks, and punched blanks to support the following connections per work area requirements.
 - 1) RJ-45 Category 6 jack per ANSI/TIA/EIA-568-C.2
 - 2) RJ-45 Category 6A jack per ANSI/TIA/EIA-568-C.2
 - 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

2.6 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.

2.7 FIELD-TERMINATED PLUG, CATEGORY 6A

- A. Manufacturers:
 1. Hubbell Premise Wiring
 2. The Siemon Company
 3. Systimax GigaSpeed Products
 4. Leviton
- B. Basis of Design – Hubbell Premise Wiring SP6A & SP6A90 (Right angled) or Coupler Assembly SCP6Axxxy (18", 3', 5', 7', 10')
- C. Application – Wireless Access Points, IP cameras and other remote IP devices.
- D. Design Requirements:
 1. The plug shall meet the following criteria:
 2. Meet or exceed all requirements for Category 6A as described in ANSI/TIA-568-C.2.
 3. Compliant with ANSI/TIA-1096-A.
 4. Accommodate T568A/B wiring schemes.
 5. Accommodate 26-22 AWG shielded or unshielded, solid or stranded conductors.
 6. Support Power over Ethernet (PoE) up to 100 watts.
 7. Connector body constructed of die-cast zinc
 8. Suitable for plenum areas.
 9. UL listed.

2.8 CABLE LABELS

- A. Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

2.9 OUTLET PLATE & PATCH PANEL LABELS

- A. Preprinted, flexible, self-adhesive vinyl with legend over-laminated with a clear weather and commercial resistant coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install all cables in accordance with equipment manufacturer's instructions, and with recognized industry practices, to ensure the installation complies with requirements of the NEC, ANSI/TIA/EIA-568-C.1 Commercial Building Telecommunications Cabling Standard and BICSI'S "Telecommunication Distribution Methods Manual" (current edition).
- B. Install all cables only when the temperature is between 32°F to 122°F.
- C. Wiring Method: Wiring shall be installed in EMT conduit within walls and above inaccessible ceilings. Wiring shall be installed in cable tray where it is present. Wiring installed above accessible ceilings between ceiling mounted devices or conduit stub-ups and the cable tray shall be exposed and supported by J-hooks, spaced a maximum of 5'-0" on center, with minimum 1" flat bearing surface. Provide conduit sleeves, bushings and fireproofing through all wall penetrations. All wiring not in EMT conduit shall be kept a minimum of 6" away from all lighting fixtures, motors, and transformers. Cables cannot be ty-wrapped or stapled to ceiling or structural supports, conduit, or other items.
- D. Test each cable as detailed in specification. Include patch cord in test channel.
- E. Identify all cables with a neatly typed label as detailed in specification.
- F. Provide horizontal and vertical cable management in all racks, on all backboards and any other location cabling is not routed in conduit or cable tray. Size cable management for 50% additional cables.
- G. UTP Cable Length:
 - 1. Maximum installed length of each UTP cable between closet and workstation outlet is to be 90 meters (295'). Ensure lengths are within specification prior to installation. Contact Engineer for procedure in the event of excessive distances prior to installation.
 - 2. Minimum length shall be 15 meters (49'). Provide service loop as required to increase length on short runs.
- H. Install cable without damaging conductors, shield or jacket, do not use unjacketed pairs for jumpers.
- I. Do not bend cable in handling or in installing to smaller radii than minimums recommended by manufacturer.
- J. No splicing is permitted for UTP cables. Cables must be continuous between termination points. Make splices, taps and terminations only at indicated outlets, terminals, cross-connect and patch panels.
- K. Provide at least 10' of cable slack at MDF or IDF closet. This slack may be stored in the cable tray or a cable management device behind the MDF/IDF.
- L. Provide 2' diameter in service loops or use figure-8 or serpentine.

- M. Provide at least 1' of slack at each workstation outlet. This slack may be coiled within device box observing bend radius minimum or within accessible ceiling space using approved J-hook support.
- N. Remove jacket of cable and untwist individual UTP conductors the minimum amounts required to terminate on jacks and patch panels.
- O. Category 6A cable fill in conduit is 40% maximum as follows:
 - 1. 3/4" - 3 UTP Cables
 - 2. 1" - 6 UTP Cables
 - 3. 1-1/4" - 10 UTP Cables
 - 4. 1-1/2" - 13 UTP Cables
 - 5. 2" - 22 UTP Cables
 - 6. 2-1/2" - 31 UTP Cables
 - 7. 3" - 49 UTP Cables
 - 8. 3-1/2" - Not recommended
 - 9. 4" - Not recommended
 - 10. Provide larger conduits than recommended for cable fill if indicated on the Drawings.
- P. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 - 1. Pull cables simultaneously if more than one is being installed in the same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway.
- Q. Secure and support cable at intervals not exceeding 5'-0" and not more than 1'-0" from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- R. Wiring within IDF/MDF and Enclosures: Provide adequate length of conductors. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- S. Separation of Wires: Comply with EIA/TIA-569 rules for separating unshielded copper telecommunications equipment cables from potential EMI sources, including electrical power lines and equipment.
- T. Support raceways, cabinets, and all other equipment in accordance with manufacturer's instructions.

3.3 LABELING

- A. System: Use a unique, 3 syllable alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
 - 1. First syllable identifies and locates wiring closet or equipment room where cable originates.
 - 2. Second syllable identifies and locates cross-connect or patch-panel field in which cable terminates.

3. Third syllable designates type of media (copper or fiber) and position occupied by cable pairs or fibers in the field.
4. Example: A2-2-C46

- B. Workstation: Label cables within outlet boxes.
- C. Within Connector Fields, in IDF/MDF Rooms and Consolidation Points: Label each connector and each discrete unit of cable terminating and connecting hardware. Where similar jacks and plugs are used for both communication and data-processing equipment, use a different color for jacks and plugs of each service.
- D. Cables, General: Label each cable within 4" of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
- E. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 100 feet.
- F. Cable Schedule: Post in prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Provide electronic copy of final comprehensive schedules for project, in software and format selected by Owner.

3.4 GROUNDING

- A. Comply with Section 260526 and applicable details on plans.
- B. Provide connections to the main ground bus on all backboards, telephone line protectors, IDF Racks and MDF Racks in the project. Connect to ground buses with cables per Specification Section 260526 and applicable details on plans.

3.5 FINAL TESTING AND INSPECTION

- A. Provide testing in accordance with ANSI/TIA/EIA-568-C.1.
- B. Cable Test: Provide prior to substantial completion, a Performance Evaluation Report, which will contain the following:
 1. Cable Test: List by cable number each UTP Cable in the project, which details:
 - a. UTP Cables:
 - 1) Cable ID Number
 - 2) List continuity, reversal, open, shorts and miswires
 - 3) Category performance
 - 4) List other discrepancies with the UTP installation (bad terminations, faulty labeling, etc).
 - 5) Tester printout for each cable.
 2. UTP Cable Testing: Test each cable pair of each cable after installation for Specified Category performance. Conduct test with a tester designed for testing above cable (with RJ-45 jacks installed) from each data outlet to associated patch cord through +0 panel jack

(Channel). Provide printout for each test as part of the Performance Evaluation Report. Minimum performance categories for report are to be as follows:

- a. Wire Map/Continuity
 - b. Length
 - c. Near End Crosstalk (pair to pair) NEXT
 - d. Near End Crosstalk (power sum) PSNEXT
 - e. Equal Level Far-End Crosstalk Loss (pair to pair) ELFEXT
 - f. Equal Level Far-End Crosstalk Loss (power sum) PSELFEXT
 - g. Return Loss
 - h. Attenuation
 - i. Propagation Delay
 - j. Delay Skew
 - k. PSACR (Powersum Attenuation – Crosstalk Ratio)
3. System Performance Report: Provide a narrative detailing the system as a whole, in regard to the quality of installation and any discrepancies affecting performance. This narrative to indicate a summary of the above Cable Test, as well as an accurate summary of specified Category performance as well as capability of the cabling system to perform at specified Category bandwidth.

3.6 WARRANTY

- A. The installation shall be provided with a minimum 25-year warranty for strict compliance with the performance requirements of ANSI/TIA/EIA-568-C.1 to support and conform to ANSI/TIA/EIA-568-C.1 specifications covering any current or future application which supports transmission over a properly constructed horizontal cabling system premises network which meets the channel performance as described in ANSI/TIA/EIA-568-C.2.

END OF SECTION 271501

SECTION 277000 – LOCAL AUDIO-VISUAL REINFORCEMENT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish and install, as hereinafter specified, complete sound systems, loudspeakers, wiring, etc., all ready for operation. The intent of these specifications is to provide complete and satisfactory operating systems for the pickup, amplification, and reproduction of voice and/or music. All equipment and installation material required shall be furnished whether enumerated herein or not.**
- B. Scope of Work:**
 - 1. Board Room Audio/Visual System**
 - 2. Field Hockey/Soccer Field Audio System**
 - 3. Multi-Purpose Field Audio System (Bid Alternate EC-5 - Refer to Section 012300 and Electrical Site Plans for additional information)**

1.2 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 270010.**
- 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.*
- C. *Operation Data: Include instructions for operating equipment. Include instructions for operating equipment under normal conditions.*
- D. *Maintenance Data: Include data in the maintenance Manual specified in Non-Technical Specifications.*
- E. *Maintenance Instructions: Submit manufacturer's printed instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under use conditions. Submit three complete sets of operating instructions including wiring and circuit diagrams. All manuals shall be delivered on CD-ROM. Site specific wiring diagrams and installation information shall be in PDF format with book-marked links.*
- F. *Inventory: Supply with the manuals an inventory of the 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 in accordance with the requirements of Division 1. 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 (10) years of 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 thirty (30) mile radius of the installation with spare service replacement parts. AV contractor's lead Installation technician must have minimum (5) years of commercial AV experience.*
- D. *The supplier 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.*
- E. *The supplier must have technicians on staff with Dante and Q-SYS training course certifications.*
- F. *AV Systems Contact:
Jordan Hykes
B&B Integrations. - (717) 295-5555
Email: jmhykes@bbintegrations.com*

1.6 WARRANTY

- A. *Provide the warranty specified in Section 260010.*

PART 2 - PRODUCT

2.1 BOARD ROOM AUDIO SYSTEM

- A. *The Board Room shall be provided with a complete locally controllable sound system including digital equalization, feedback filtering, Wireless microphones, and specifications as follows.*
- B. *Note: All Equipment shall conform to the manufacturer's latest published specifications in feature and function both physically and electrically whether those specifications are delineated herein or not. The manufacturer's latest published specifications shall be considered as part of this text.*
- C. *The system processor shall provide up to 160 x 160 networked audio channels, individually configurable as either Q-LAN, AES67, or Dante formatted networked audio. Additionally, the system processor shall include 8 x 8 Software-based Dante network audio channels and is licensable for up to 64 x 64 Software-based Dante capacity. The system processor shall support 24 total analog I/O capacity and shall be presented in the following groupings: 8 Mic/Line inputs, 8 Line outputs and 8 Flex Channel I/O which shall be software definable analog inputs or outputs in single channel increments in any combination ratio. The system processor shall be capable of connecting to any host PC, Mac or embedded device via USB and will present itself as up to four virtual external sound devices, each offering Speakerphone (with or without Acoustic Echo Cancellation) or a Soundcard plus a single USB Webcam for Soft-Codec conferencing and other applications.*
 - 1. *Provide (1) Q-SYS CORE 24f as the DSP and Control system brain.*
 - 2. *Provide (1) Q-SYS SLDAN-32-P Dante License.*

3. *All audio inputs and outputs from the Q-SYS processor shall be digital over Dante or Q-LAN except for reference audio into Televic Dante WAP.*
- D. *Provide (1) Q-SYS Model TSC-101-G3 touchscreen at each location shown on the drawings***
1. *Configure touchscreen for system on/off, video matrixing, display control, and audio in/output control per zone.*
 2. *Review touch panel programming with customer representative before deploying on site.*
 3. *Provide (1) 13" iPad for wireless control of Q-SYS system.*
 4. *Provide (1) one Netgear GSM4248UX M4250-40G8XF-PoE++ AV Line 40x1G Ultra90 PoE++ 802.3bt 2,880W and 8xSFP+ Managed Switch.*
- E. *Boardroom table shall have a control location for running the streaming system***
1. *Provide (1) BirdDog BDPLAYPRO 4K NDI Player for KVM operation at the boardroom table.*
 2. *Provide (1) Uperfect UD19BU,9 Inch 4K Color Accurate Monitor.*
 3. *Provide (1) rackmount KVM for streaming PC located in AV rack.*
- F. *The Main Power amplifier shall be a eight-channel network-processing device that is designed to operate exclusively with a QSC Q-SYS ecosystem on a Gigabit Ethernet network.***
1. *Provide one (1) Q-SYS Model CX-Q 8K8.*
 2. *Each speaker shall be on an independent channel for full zone control.*
- G. *Provide one (1) Shure Model ULXD4D-G57 dual channel digital wireless receiver.***
1. *Provide rackmount hardware required.*
 2. *Provide one (1) Shure ULXD8--G50 Wireless Gooseneck Mic Base.*
 3. *Provide one (1) Shure MX415LP/C 15" Gooseneck Mic.*
 4. *Provide one (1) Shure ULXD2/SM58--G57 handheld transmitter.*
 5. *Provide Shure rechargeable batteries and charging stations for all wireless transmitters.*
 - a. *Provide shelf in AV Rack for charging stations.*
 - b. *Provide (2) SB900C Rechargeable batteries.*
 - c. *Provide (1) SBC220 2 Bay Networked Docking Station.*
 - d. *Provide (1) SBC250 2-UP Networked Dock.*
 6. *Provide two (2) Shure UA864US remote antennas at locations shown on the drawings.*
 7. *All wireless microphones on the project shall be the same series for interchangeability.*
- H. *Provide Televic Confidea conferencing system as specified below for the dais table and podium.***
1. *Provide Confidea WAP G4 with Dante wireless access point.*
 2. *Provide Confidea WAP PS G4 PoE+ power adapter for Confidea WAP G4.*
 3. *Provide (14) Confidea Flex G4 PLM401 touch enabled wireless tabletop conference unit.*
 4. *Provide (2) Confidea Low profile microphone.*
 5. *Provide (2) Confidea CHT G4 Charging station for 10 batteries.*
 6. *Remote configuration support must be included from the manufacturer.*
 7. *(1) year service agreement from manufacturer must be included.*
- I. *Provide one (1) Middle Atlantic Products Model DWR-21-22, 21RU DWR Series Rack, 22 Inches Deep, with the following items:***

1. *Provide one (1) Middle Atlantic VFD-21 perforated door.*
2. *Provide Furman P-2400 AR AC Line Voltage Regulator.*
3. *Provide (1) APC SRT2K2RXLN145 Smart-UPS SRT Network Card with Input Cord, 10', 2200VA.*
4. *Provide (1) Middle Atlantic UQFP-4DRA,100 CFM Fan Panel with Display.*
5. *Provide (2) Q-SYS NV-RK,Rackmount kit that enables side-by-side installation of up to two NV-21-HUs, NVM-302Es, or NVM-302Ds within a 1RU space.*
6. *Provide (1) Middle Atlantic RC-4,4 RU Clamping Rackshelf Knockdown for securing Streaming PC in rack.*
7. *Provide (1) Middle Atlantic SS sliding shelf for Shure wireless microphone chargers.*
8. *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.*
9. *Blank and vented panels to fill rack.*
10. *Provide patch panels.*

2.2 BOARD ROOM VIDEO SYSTEM.

- A. *All video inputs shall be able to be matrixed on any display. Video system is based on a networked system through Q-SYS and NDI streams and protocols.*
- B. *Video inputs shall be matrixed to any display in the Boardroom.*
 1. *Provide (1) Barco C-10 Clickshare with 2 buttons for wireless sharing.*
 2. *Customer PC will be a video input via Q-SYS encoder NVM-302E.*
 3. *Provide one (1) Q-SYS NV-1 operating as the video encoder in the Podium floor box and (1) in a floor box at the boardroom table.*
- C. *Each video endpoint location shall have a Q-SYS decoder NVM-302D Decoder hardware with single 4K60 4:4:4 Mediacast decode streaming video app, Hardware features 1 HDMI 2.0 output to a single decode stream, 1 LAN, 1 USB-C, 2 USB-A, 1 RS-232, and 1 IR tx por.*
- D. *Provide (1) Maxhub NC86CMB at each wall mount TV location shown on drawings. Displays to be controlled via LAN through Q-SYS system.*
- E. *Provide all Video Cables, Transmitters, Receivers, Interface Cables and Connection Blocks necessary for a complete and operational system.*

2.3 BOARD ROOM CAMERAS

- A. *The boardroom cameras shall be BirdDog NDI cameras.*
 1. *Provide (1) BirdDog BDX1-30W X1 30x Optical Zoom for the rear camera.*
 - a. *Confirm camera color prior to installation.*
 2. *Provide (1) BirdDog BDX4EUW X4E Ultra 20x 2160p60 4K PTZ Camera for the front camera.*
 - a. *Confirm camera color prior to installation.*
 3. *Provide wall mounts for all cameras.*
 4. *Cameras are NDI cameras and shall be switched and controlled through streaming PC.*

2.4 BOARD ROOM LOUDSPEAKERS

- A. The Boardroom loudspeakers shall be Q-PL-DC24 Dual 4-in 2-way passive directivity control loudspeaker.**
- 1. Provide Speakers at locations shown on the drawings.**
 - 2. Provide Q-SYS manufactured yoke mounts for each speaker.**
 - 3. Each speaker shall be on a separate amplifier channel.**

2.5 FIELD HOCKEY/SOCCER FIELD AUDIO SYSTEM

- A. The Field Hockey/Soccer Field shall be provided with a complete locally controllable sound system including digital equalization, feedback filtering, Wireless microphones, and specifications as follows.**
- B. Note: All Equipment shall conform to the manufacturer's latest published specifications in feature and function both physically and electrically whether those specifications are delineated herein or not. The manufacturer's latest published specifications shall be considered as part of this text.**
- C. The system processor shall provide up to 160 x 160 networked audio channels, individually configurable as either Q-LAN, AES67, or Dante formatted networked audio. Additionally, the system processor shall include 8 x 8 Software-based Dante network audio channels and is licensable for up to 64 x 64 Software-based Dante capacity. The system processor shall support 24 total analog I/O capacity and shall be presented in the following groupings: 8 Mic/Line inputs, 8 Line outputs and 8 Flex Channel I/O which shall be software definable analog inputs or outputs in single channel increments in any combination ratio. The system processor shall be capable of connecting to any host PC, Mac or embedded device via USB and will present itself as up to four virtual external sound devices, each offering Speakerphone (with or without Acoustic Echo Cancellation) or a Soundcard plus a single USB Webcam for Soft-Codec conferencing and other applications.**
- 1. Provide (1) Q-SYS CORE 24f as the DSP and Control system brain.**
 - 2. Provide (1) Q-SYS SLDAN-32-P Dante License.**
 - 3. All audio inputs and outputs from the Q-SYS processor shall be digital over Dante or Q-LAN.**
 - 4. Provide (1) Q-SYS TSC-101-G 10.1" Touch Screen at rack location.**
- D. Provide one (1) GEEKLAND model GK-NWY10-WIN touchscreen PC with (1) GEEKLAND GK-NWY10-WIN at each location shown on the drawings.**
- 1. PC to run Q-SYS UCI viewer for control of the field.**
 - 2. Configure touchscreen per customer's expectations.**
 - 3. Provide (1) Q-SYS, unD6IO,4x2 Channel Dual Gang US, Dante/AES67 Wall Plate 2 Mic/Line In (XLR), RCA, 3.5 mm I/O, PoE) at each location shown on the drawings.**
 - 4. Provide (1) Muxlab 500554-WH Bluetooth Audio to Dante 1-Gang Wallplate - White at each location shown on the drawings.**
 - 5. Provide each location with an outdoor rated enclosure sized to accommodate all equipment.**

- E. Provide (1) Netgear GSM4248UX M4250-40G8XF-PoE++ AV Line 40x1G Ultra90 PoE++ 802.3bt 2,880W and 8xSFP+ Managed Switch.**
- F. The Main Power amplifiers shall be a four-channel network-processing device that is designed to operate exclusively with a QSC Q-SYS ecosystem on a Gigabit Ethernet network.**
 - 1. Provide two (2) QSC Model CX-Q 8K4.**
 - 2. Each Speaker shall be an independent amplifier channel.**
- G. Provide one (1) Shure Model ULXD4QGV--G50 quad channel digital wireless receiver.**
 - 1. Provide rackmount hardware required.**
 - 2. Provide two Shure (2) ULXD2/SM58--G50 handheld transmitter.**
 - 3. Provide Shure rechargeable batteries and charging stations for all wireless transmitters.**
 - a. Provide space in AV Rack for charging stations.**
 - 4. Provide Lectrosonics ALP690, high-performance LPDA (log periodic dipole array) antenna remote antennas at locations shown on the drawings.**
 - a. Antennas to be mounted on the roof of the DAO.**
- H. Provide two (2) Shure SM58S wired microphones for use with XLR inputs.**
 - 1. Provide two (2) Rapco 50FT XLR Cables.**
- I. All necessary power supplies, relays, connectors, and hardware necessary to provide remote switching functions as described shall be provided.**
- J. Provide one (1) Middle Atlantic Products Model DWR-18-22 18 Space Sectional Wall Rack and furnish the following items:**
 - 1. Provide (1) Middle Atlantic VFD-18 Vented Door**
 - 2. Provide (1) Middle Atlantic, UQFP-4DRA, 100 CFM Fan Panel with Display, 27dB, Anodized**
 - 3. Provide (1) Middle Atlantic SS sliding shelf for Shure wireless microphone chargers**
 - 4. Provide (1) Furman P-2400 AR AC Line Voltage Regulator**
 - 5. Provide (1) APC SRT2K2RXLNX145 Smart-UPS SRT Network Card with Input Cord, 10', 220VAA**
 - 6. 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.**
 - 7. All equipment mounting hardware required.**
 - 8. Vented panels to fill rack.**

2.6 FIELD HOCKEY/SOCCER FIELD LOUDSPEAKERS

- A. The Field Hockey/Soccer Field loudspeakers shall have two models of loudspeakers.**
 - 1. One model shall be a Danley OSC12CX 2 Way Outdoor Loudspeaker.**
 - a. Provide (4) Danley OSC12CX; (1) at each of Musco poles #S1 thru S4 aimed at the bleachers.**
 - b. Loudspeakers shall be mounted with structurally rated hardware.**
 - 2. One model shall be a Danley OSC15CX 2 Way Outdoor Loudspeaker.**
 - a. Provide (4) Danley OSC15CX; (1) at each of Musco poles #S1 thru S4 aimed at the playing field.**

- b. Loudspeakers shall be mounted with structurally rated hardware.*

2.7 FIELD HOCKEY/SOCCER FIELD ASSISTIVE LISTENING SYSTEMS

- A. Provide the Field Hockey/Soccer Field with a Williams AV Assisted listening system FM 558-12 PRO D with external ANT 024 antenna mounted on roof of DAO.
 - 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.**

2.8 MULTI-PURPOSE FIELD AUDIO SYSTEM (BID ALTERNATE EC-5)

- A. The Multi-Purpose Field shall be provided with a complete locally controllable sound system including digital equalization, feedback filtering, Wireless microphones, and specifications as follows.*
- B. Note: All Equipment shall conform to the manufacturer's latest published specifications in feature and function both physically and electrically whether those specifications are delineated herein or not. The manufacturer's latest published specifications shall be considered as part of this text.*
- C. The system processor shall provide up to 160 x 160 networked audio channels, individually configurable as either Q-LAN, AES67, or Dante formatted networked audio. Additionally, the system processor shall include 8 x 8 Software-based Dante network audio channels and is licensable for up to 64 x 64 Software-based Dante capacity. The system processor shall support 24 total analog I/O capacity and shall be presented in the following groupings: 8 Mic/Line inputs, 8 Line outputs and 8 Flex Channel I/O which shall be software definable analog inputs or outputs in single channel increments in any combination ratio. The system processor shall be capable of connecting to any host PC, Mac or embedded device via USB and will present itself as up to four virtual external sound devices, each offering Speakerphone (with or without Acoustic Echo Cancellation) or a Soundcard plus a single USB Webcam for Soft-Codec conferencing and other applications.
 - 1. Provide (1) Q-SYS CORE 24f as the DSP and Control system brain.*
 - 2. Provide (1) Q-SYS SLDAN-32-P Dante License.*
 - 3. All audio inputs and outputs from the Q-SYS processor shall be digital over Dante or Q-LAN.**
- D. Provide one (1) GEEKLAND model GK-NWY10-WIN touchscreen PC with (1) GEEKLAND GK-NWY10-WIN at each location shown on the drawings.
 - 1. PC to run Q-SYS UCI viewer for control of the field.*
 - 2. Configure touchscreen per customer's expectations.*
 - 3. Provide (1) Q-SYS, unD6IO,4x2 Channel Dual Gang US, Dante/AES67 Wall Plate 2 Mic/Line In (XLR), RCA, 3.5 mm I/O, PoE) at each location shown on the drawings.*
 - 4. Provide (1) Muxlab 500554-WH Bluetooth Audio to Dante 1-Gang Wallplate - White at each location shown on the drawings.*
 - 5. Provide each location with an outdoor rated enclosure sized to accommodate all equipment.**

- E. The Main Power amplifiers shall be a four-channel network-processing device that is designed to operate exclusively with a QSC Q-SYS ecosystem on a Gigabit Ethernet network.**
 - 1. Provide two (2) QSC Model CX-Q 8K4.**
 - 2. Each Speaker shall be an independent amplifier channel.**
- F. Provide one (1) Shure Model ULXD4QGV--G50 quad channel digital wireless receiver.**
 - 1. Provide rackmount hardware required.**
 - 2. Provide two Shure (2) ULXD2/SM58--G50 handheld transmitter.**
 - 3. Provide Shure rechargeable batteries and charging stations for all wireless transmitters.**
 - a. Provide space in AV Rack for charging stations.**
 - 4. Provide Lectrosonics ALP690, high-performance LPDA (log periodic dipole array) antenna remote antennas at locations shown on the drawings.**
 - a. Antennas to be mounted on the roof of the DAO.**
- G. Provide two (2) Shure SM58S wired microphones for use with XLR inputs.**
 - 1. Provide two (2) Rapco 50FT XLR Cables.**
- H. All necessary power supplies, relays, connectors, and hardware necessary to provide remote switching functions as described shall be provided.**
- I. Mount equipment in rack specified in Paragraph 2.5.J.**
 - 1. Provide all equipment mounting hardware required.**

2.9 MULTI-PURPOSE FIELD LOUDSPEAKERS (BID ALTERNATE EC-5)

- A. The Multi-Purpose Field loudspeakers shall have two models of loudspeakers.**
 - 1. One model shall be a Danley OSC12CX 2 Way Outdoor Loudspeaker.**
 - a. Provide (4) Danley OSC12CX; (1) at each of Musco poles #S5 thru S8 aimed at the bleachers.**
 - b. Loudspeakers shall be mounted with structurally rated hardware.**
 - 2. One model shall be a Danley OSC15CX 2 Way Outdoor Loudspeaker.**
 - a. Provide (4) Danley OSC15CX; (1) at each of Musco poles #S5 thru S8 aimed at the playing field.**
 - b. Loudspeakers shall be mounted with structurally rated hardware.**

2.10 MULTI-PURPOSE FIELD ASSISTIVE LISTENING SYSTEMS (BID ALTERNATE EC-5)

- A. Provide the Field Hockey/Soccer Field with a Williams AV Assisted listening system FM 558-12 PRO D with external ANT 024 antenna mounted on roof of DAO.**
 - 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.**

2.11 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.**

2.12 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 loudspeaker wiring shall be 12-awg minimum.**
- D. All microphone wiring shall be 22awg stranded.**
- E. All wiring shall be plenum rated.**

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 Owner's 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

(Addendum 5)

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.

(Addendum 5)

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. Presentation Controller: Furnish 1 of each type and rating installed.~~

~~2. Interface Module: Furnish 1 of each type and rating installed.~~

~~3. HDMI Outlet: Furnish 1 of each type and rating installed.~~

~~4. USB Outlet: Furnish 1 of each type and rating installed.~~

~~5. Amplifier: Furnish 1 of each type and rating installed.~~

~~6. Loudspeakers: Furnish 2 of each type and rating installed.~~

1. HDMI Outlet: Furnish 4 of each type and rating installed.

2. HDMI Cable: Furnish 2 cables of 50' length.

(Addendum 5)

1.6 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS

2.1 HDMI OUTLETS

- A. **Comprehensive Model WPD-HD1-AX**
 - 1. Single Gang Decorative Wall Plate with matched color ABS face plate
 - 2. One (1) HDMI Female Port (with HDMI female pigtail)
- B. Provide one (1) at each TS and one (1) at each TV1 outlet.

2.2 HDMI CABLES

- A. **Comprehensive Model HD18G-XXPROBLK**
 - 1. Performance Grade: Best
 - 2. Connector Type 1: HDMI Male with ProGrip Technology & SureLength Indicators

3. **Connector Type 2: HDMI Male with ProGrip Technology & SureLength Indicators**
4. **Bandwidth or Speed: 18Gbps (End to End), HDR Support**
5. **Resolution: 4K @ 60Hz 4:4:4**
6. **Bend Radius: Up to 15ft: 3.35 inches. 20ft and up: 3.5 inches**
7. **Gauge: Up to 15ft: 26AWG. 20ft and up: 24AWG, Please note: Lengths 25ft, 35ft, 50ft are active and directional**
9. **Center Conductor: 99.9% High Purity Copper**
10. **Connector Finish: 24K Gold Plated**
11. **Shielding: Triple Shielded, Inner 100% Aluminum Mylar Wrap, Outer 100% Aluminum**
12. **Mylar Wrap, 85% Tinned Copper Braid**
13. **Cable Outer Diameter: Up to 15ft: 0.33" (8.5mm), 20ft and up: 0.35" (9.0mm)**
14. **Jacket Type: Matte PVC**
15. **Jacket Color: Jet Black**

B. Provide cable lengths as required to connect the TS and TV1 outlets in the room.

(Addendum 5)

2.3 PROJECTOR/DISPLAY BRACKET

- A. Furnished by Owner and installed by the Electrical Contractor.

2.4 PROJECTOR/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 6 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 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 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.

1.10 OWNER FURNISHED EQUIPMENT FOR INSTALLATION

- A. Interior Cameras
- B. Exterior Cameras

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.
- B. Wire Rod Type Cable Tray: Refer to Section 260536 for wire rod type cable tray.

2.4 CONDUITS AND BACKBOXES

- A. Refer to Section 260533 for raceways and boxes.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS

- A. Verify locations and mounting heights with the electronic safety & security equipment.
- B. Install Owner furnished equipment.

3.2 FIRESTOPPING

- A. Penetrations in fire rated partitions shall be sealed to maintain the fire integrity of the assembly. Provide fire stopping meeting the same rating as the assembly being sealed.

- B. All firestopping shall meet the requirements of ASTM E-814 and UL 1479.
- C. Comply with all installation requirements of Division 7.

3.3 HANGERS AND SUPPORTS INSTALLATION

- A. Provide supports as required to support all cabling.
- B. Provide cable tray as required to support all cabling.
- C. Comply with all installation requirements of Sections 260529 and 260536.

3.4 CONDUITS AND BACKBOXES INSTALLATION

- A. Provide raceways and boxes as required for cabling.
- B. Comply with all installation requirements of Section 260533.
- C. The minimum conduit size for conduit pathways and stub-outs shall be 3/4 inch.

3.5 SLEEVE INSTALLATION FOR PENETRATIONS

- A. Penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2" above finished floor level.
- G. Size pipe sleeves to provide 1/4" annular clear space between sleeve and pathway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants".

- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
- K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1" annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 SYSTEM WIRING METHODS

- A. Provide pathways as required in accordance with the following paragraphs. Where wiring is required by other specification sections, provide communications wiring in accordance with the following paragraphs.
 - 1. Wire Routing: Route all device wiring from each device up into accessible ceiling cavity within metallic conduit in recessed or unfinished areas and within surface raceway for renovated non-fishable areas. Stub all conduits into accessible ceiling cavity and provide bushing for each.
 - 2. Cable Routing: Route cable for all device wiring within accessible ceiling cavities. Install cable supports at 4' spacing maximum or in cable tray where applicable. No cabling is to lie on or attach to ceiling tile, ducts, pipes, conduits or ceiling suspension wires, rods, or structural members. Provide conduit stubs from devices and panels to the ceiling cavities. Use cable tray for support when it is shown on the drawings.
 - 3. Route all system wiring from system equipment within metallic conduit up into nearby ceiling cavity and connect to the wiring system indicated in 1 and 2 above. Provide bushings at conduit ends.
 - 4. Provide raceways for cabling in all open structure ceiling spaces.
 - 5. Refer to individual sections for methods specific to that system.

3.8 CEILING TILE REMOVAL

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

END OF SECTION 280500

SECTION 282300 – VIDEO SURVEILLANCE SYSTEM CABLING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide cabling and install cameras 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.

2.3 POLE MOUNTED EQUIPMENT ENCLOSURE

- A. 18x16x10 polycarbonate weatherproof NEMA 3R enclosure, 120VAC mounting plate mechanical thermostat heat and 85°F turn on fan in dark gray.
- B. Provide L-Com Model NBPC181610-1HF-1 where indicated on Drawings.
 - 1. EC to adjust enclosure size as required so all equipment can mount inside.
- C. Provide pole mounting bracket as required for mounting on the site lighting pole.

2.4 EXTERIOR CAMERA ELECTRONICS

- A. Robust industrial, full gigabit ethernet switch.
 - 1. Provide one Cisco model IE-3200-8P2S-E in each enclosure.
- B. Din-Rail switch power supply.
 - 1. Provide one Cisco model PWR-IE240W-PCAC-L for each switch.
- C. Provide connectors and patch cables as required.

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.
- F. Install cameras and mounting brackets furnished by the Owner.
- G. Pole Mounted Cameras: Provide (1) Category 6A indoor/outdoor cable from pole mounted equipment enclosure to camera with connectors required on each end.
- H. Equipment Enclosure Power: Provide power wiring in conduit as indicated on the drawings.

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. Provide power supplies as required.

2.3 DOOR ENTRANCE STATION

- A. Provide Aiphone model IX-DVM – IP Mullion Mount IP Video Door Station 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-MAA – Network Door Release Relay as required for the door release functions.
 - 2. Provide enclosure for devices to be installed above the ceiling.

2.5 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.

2.6 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 to nearest cable tray. 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 6 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 283111 – DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire Alarm Control Equipment
- B. Manual Initiating Devices
- C. Automatic Initiating Devices
- D. Notification Appliances
- E. Fire Alarm Interface Modules

1.2 RELATED WORK/DIVISIONS

- A. Division 1
- B. Division 8
- C. Division 23

1.3 REFERENCES

- A. Pennsylvania Construction Code Act (Title 34)
- B. International Building Code
- C. NFPA 70 - National Electric Code as adopted by IBC
- D. NFPA 72 – National Fire Alarm Code as adopted by IBC
- E. International Fire Code
- F. International Mechanical Code
- G. International Electrical Code
- H. NFPA 101 – Life Safety Code
- I. NFPA 1 – Fire Prevention Code

1.4 SYSTEM DESCRIPTION

- A. Addressable Fire Alarm System: Non-coded, addressable microprocessor-based fire alarm system with initiating devices, notification appliances, monitoring and control devices, and connection to an approved Supervising Station. The Notification Appliances on this project shall be **Speakers** and **Speaker** Strobes. It is the responsibility of the system integrator to furnish the appropriate amount of signal extender and amplifier panels needed to support all notification appliances shown on the project drawings.

(Addendum 5)

1.5 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 260010.
- B. Shop Drawings: The following items shall be submitted for review and approval:
 - 1. Submittal booklet to include the following:
 - a. A list of all equipment to be provided and installed in the system
 - b. Data sheets of all items to be provided with the specific item or model number highlighted
 - c. Required support documentation indicating the authorized relationship of the system supplier and copies of certifications and listings that are required in the specifications.
 - d. Fire Alarm Cable
 - e. Matrix of operation of the system
 - f. Standby battery calculations
 - 2. Upon approval of the submittal material, provide system drawings, prepared in AutoCAD, to include the following:
 - a. All control equipment with interconnecting wiring
 - b. Field connections of all circuits connecting to the control equipment
 - c. Floor layouts with fire alarm system device locations shown
 - d. Addressable device numbers for each addressable device
 - e. Notification appliances circuited and numbered, with candela setting for visual units and output setting for audible units
 - f. Typical device connections for each type device used in the system
 - g. Basic riser diagram to include control equipment and all field circuits
 - h. Indicate temperature settings of thermal detectors.
- C. Local Code Authority Submission: It shall be the responsibility of the Approved Equipment Supplier to provide the required materials and submittal data, including drawings, to the Local Authority Having Jurisdiction (AHJ) for their review and approval if necessary. Any fees for the submission and approval process shall be the responsibility of the installing contractor.

1.6 SUBMITTALS FOR CLOSEOUT

- A. Submit under provisions of Section 260010.

- B. Record of Completion: The equipment supplier shall complete the Record of Completion as required in NFPA 72. Any deficiencies that are to be listed on the Record of Completion shall be reviewed with the Architect/Engineer on record for the project before the authority having jurisdiction is requested to sign the document. Upon approval, the original copy of the completed Record of Completion, signed by all required parties, shall be submitted through the Contractor to the Architect/Engineer and Building Owner.
- C. Drawings of the completed system reflecting any changes that were made from the original submission of drawings.
- D. Copy of the system program in printed form and on a USB thumb drive.
- E. Operating and Instruction Manuals of the entire system.
- F. Copy of the Testing and Maintenance Agreement for the first year of service.
- G. Copy of the Supervising Station Monitoring Agreement.
- H. Copy of the Certificate for Listing or Placarding the system.
- I. System Program: The equipment supplier shall provide a copy of the latest system program in printed form and on a USB thumb drive.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Equipment Supplier: Shall be a local Company or local Branch office that is authorized by contract to provide all the products and equipment to be installed in the fire alarm and detection system. Upon request, a current letter provided within the past 30 days, shall be provided to the Architect/Engineer of the Authorized relationship between the Manufacturer and the Equipment Supplier. In addition, the Equipment Supplier shall have the following minimum certifications and listings:
 - 1. A minimum of one individual who works full time with the local office of the Equipment Supplier supporting this project who is NICET Certified in Fire Alarm Systems at Level IV or higher. A copy of a current Certification Certificate shall be included in the Submittal Data required above.
 - 2. The Equipment Supplier shall be listed by Underwriters Laboratories, Inc. (U.L.) under category UUJS for Protective Signaling Systems or Factory Mutual Research Approved (FM) for Fire Alarm Service – Local Companies under Standard 3011. A copy of a current Listing or Approved Certificate shall be included in the Submittal Data required above.
- C. Installer: Company specializing in installing the products specified in this section with minimum 3 years documented experience. Certified by the state and/or local governments as fire alarm installer when required by law. In lieu of the installers being certified when required by local AHJ, the Equipment Supplier shall be responsible for certifying the installation.

1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70, NFPA 72 and locally enforced codes.
- B. Furnish products listed and classified by UL, FM or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.
- C. Interconnecting equipment, initiation devices, notification appliance circuit extenders, and annunciating devices shall be UL listed to operate as a unit although manufacturers may differ.

1.9 MAINTENANCE SERVICE

- A. Inspection and Testing Agreement: As required for U.L. Certifying a Remote Supervising Station System, the Equipment Supplier shall furnish a full-service Testing and Maintenance Agreement to support the system during the first year of operation or for one year from Date of first beneficial use of the system. During this period, the Equipment Supplier shall provide the following at no additional cost to the Owner:
 - 1. Required Inspections and Testing
 - 2. Emergency Service during normal working hours
 - 3. Certifying the system for Remote Supervising Station service
 - 4. First Year monitoring service through a U.L. Listed Supervising Station or other Supervising Station approved by the local AHJ or Owner.
 - 5. Repair or replacement of any required parts, provided they have not been abused or misused by abnormal conditions such as vandalism, fire, water damage, lightning damage or other abnormal conditions.
- B. Service Not Covered by Above
 - 1. Service or labor desired by the Owner outside normal working hours of Monday through Friday from 8:00 AM to 5:00 PM shall be charged at the Equipment Suppliers normal published rates.
 - 2. Repair or replacement parts required due to abuse or other abnormal use, upon Owner approval shall be charged by the Equipment Supplier at published prices.
- C. Service Agreement Renewal: The Equipment Supplier shall provide to the Owner at the time the system is turned over for first beneficial use, a Service Agreement Renewal proposal to cover the following:
 - 1. Two (2) additional years for an Inspection, Testing and Maintenance Agreement to meet the current codes in effect.
 - 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 **3** of each type and rating installed. **(Addendum 5)**
 - 2. Heat Detector: Furnish **2** of each type and rating installed. **(Addendum 5)**
 - 3. Manual Pull Station: Furnish 2 of each type and rating installed.

4. Audible Indicating Devices: Furnish 2 of each type installed.
5. Visual Indicating Devices: Furnish 2 of each type installed.
6. Audible/Visual Devices: Furnish 5 of each type installed.
7. Contact Interface Module: Furnish 1 of each type.
8. Keys: Furnish 6 of each type.
9. Handheld Detector Programmer: Furnish 1 of each type required.

1.11 WARRANTY

- A. Provide the warranty specified in Section 260010.

PART 2 - PRODUCTS AND OPERATIONS

2.1 MANUFACTURERS

- A. Provide a Fire Alarm and Automatic Detection System that is manufactured by a company that has a complete line of the products required for this project and has been successfully represented in this area for five years or more. Obtain fire alarm and automatic detection system components through one source from a single manufacturer who assumes responsibility for compatibility of system components. Following is a list of manufacturers that are known to meet these criteria. However, the specific equipment specifications and operations of the system to be provided for this project and the qualifications of the Authorized Representative (Equipment Supplier) of the manufacturer must meet or exceed the specifications to be considered for approval.
 - ~~1. — Siemens Fire Safety~~
 - ~~2. — Edwards Systems Technology~~
 - ~~3. — Notifier~~
 1. **Kidde VM Series by ESCO Security – NO SUBSTITUTIONS; District Standard (Addendum 5)**

2.2 FIRE ALARM CONTROL PANEL

- A. Control Panel: Modular construction with flush or surface wall mounted enclosure as indicated on the Drawings.
- B. Power supply: Shall be an integral part of the control equipment and include primary and secondary power circuits. The secondary supply shall automatically supply power to the system upon loss of primary power. The secondary power shall be sized to meet the Remote Station requirements of 24-hours of system operation under maximum quiescent load, plus 15 minutes of full load operation under an alarm condition. Provide power supplies and batteries with a minimum of 20% spare capacity. These secondary power capacities shall apply to all remote controls, alarm extender panels, supervising station reporting units and other ancillary controls provided with the system. Provide dedicated 24-volt DC power supplies for all magnetic door (smoke door) hold-open devices.

- C. System Supervision: All initiating device circuits, notification appliance circuits, and ancillary circuits shall be supervised as class B circuits. All end-of-line device locations shall be clearly marked on the drawings.
- D. Initiating Device Circuits: Signaling line circuits shall be limited to a maximum of 50 devices without short-circuit protection. Circuits over 50 devices shall require circuit isolation modules to prevent short-circuits from affecting more than 50 devices. Each initiating device circuit shall be loaded to not more than 80% of its maximum number of addresses.
- E. ***Emergency Communication System shall be complete, electrically supervised evacuation system using one-way communication with microprocessor-based operating system having the following capabilities, features and capacities:***
 - 1. ***Listed for emergency and non-emergency use.***
 - 2. ***Listed for MNS from any control point to 'Request/Grant/Deny' and integrated with the system (no separate MNS panel).***
 - 3. ***Ability to support up to two microphones per control panel for one-way paging, and up to 64 microphones in a voice network.***
 - 4. ***Ability to provide manual voice control.***
 - 5. ***Two channel message player supporting 300 messages (38 pre-recorded). The system supports MP3 and WAV files).***
 - 6. ***Minimum of (1) simultaneous audio channel for each networked panel.***
 - 7. ***Amplifiers shall be rated for 25V or 70.7V RMS, 50 watts. Voice amplification shall be supervised and backed up with like amplifiers. Back up shall be one or two per node.***
 - 8. ***Ability to provide separate booster amplifier. Amplifiers shall be rated for 25V or 70.7V RMS, 100 watts.***
 - 9. ***The system shall have the capability to support Peer-to-Peer or Master-Slave network and voice configurations.***
 - 10. ***Multiple nodes shall provide peer-to-peer voice capability in order to eliminate a single point of failure.***
 - 11. ***Audio shall be synchronized between nodes in order to take into account common areas.***
 - 12. ***Speakers shall have the ability to play coded audio tones.***
 - 13. ***The system shall provide status indicators and control switches for all the following functions:***
 - a. ***Audible and visual notification alarm circuit zone control.***
 - b. ***Speaker circuit zone control.***
 - c. ***Status indicators for sprinkler system water flow and valve supervisory devices.***
 - d. ***Any additional status or control functions as indicated on the drawings, including but not limited to emergency generator functions, fire pump functions, door unlocking, and security with bypass capabilities.***
 - 14. ***The Voice Amplifier shall provide 25/70 V with a minimum of 50W amplifier. Up to four (4) amplifiers shall be capable of being are supported in a 3-to1 backup, or 1-to-1 backup schematic on a single intelligent voice-communication system: configured as one (1), two (2) or three (3) main amplifiers, and one (1) or two (2) optional backup amplifiers.***
 - 15. ***The Microphone Module shall be provided for live, non-pre-recorded voice communication on an intelligent voice communication panel. The microphone option module can serve either as a main microphone installed in the main-system enclosure, or as a remote microphone in a remote enclosure. Up to two (2) microphones are supported for each FACP.***

16. ***The Switch Option Module is a series of front-end, illuminated, and programmable pushbuttons primarily mounted in the middle inner door of each intelligent voice-communication FACP. Each switch- module has 24 group-switches, thus totaling 48 LEDs, and consists of up to 96 multi-color LED-status indicators. Each LED switch-group is assigned specific functionality during the configuration process. Furthermore, a pushbutton [for each affected zone] will illuminate to acknowledge the command has been received at the Voice System CPU Card. Additionally, if no microphone is used, up to eight (8) switch-option modules can be used in a given three-eight-unit (3HU) enclosure.***
17. ***The Booster Amplifier Option Module is a main board that allows for expansion of speaker zones for additional power to an intelligent voice communication system.***

(Addendum 5)

- F. Notification Appliance Circuits: Supervised notification modules, shall be installed as class B circuits with end-of-line device locations clearly marked on the drawings. Load signal circuits and modules to not more than 80% of rated capacity.
- G. Notification Appliance Circuit Supervision: All visual notification appliances throughout the facility shall be synchronized. All audible notification appliances throughout the facility shall be synchronized and operate on the temporal code 3 pattern. Visual and audible notification appliances shall be controlled independently allowing either to be silenced or operated manually at the control unit.
- H. Digital Communicator: The Multi-Point Digital Alarm Communicator shall be UL864 listed to provide point identification of alarm, supervisory, security and trouble events to a Central or Remote Receiving Station. The DACT shall support the following:
 1. Ademco Contact ID or SIA protocol
 2. Ademco Contact ID selection shall provide the ability to transmit events for up to 999 individual zones
 3. SIA selection shall provide the ability to transmit events for up to 10,000 individual points
 4. Programming of accounts and phone numbers
 5. Cellular connectivity.
 6. Line fault monitoring.
 7. Automatic 24-hour test
 8. The DACT supports configurable alarm, alarm restoral, trouble, trouble restoral, supervisory, supervisory restoral, and reset events.
 9. The DACT supports Ademco Contact ID alarm event codes for general alarm, smoke detector alarm, waterflow alarm, duct alarm, and manual alarm events.
 10. Optionally, the DACT can be programmed to report events by event queue only.
- I. Commercial Cellular LTE Communicator: Provide Starlink SLETEVI-CFB-PS, Advanced LTE Dual Diversity Antenna for optimized performance or equal as follows:
 1. 3 LED Indicators - Green, Signal Strength; Amber- Busy/ Activation; Red-Trouble
 2. Patented Signal Boost™ signal amplification circuit and high-gain performance antennae
 3. Operating Environment: 0 to 49°C (32-120°F), up to 93% humidity (non-condensing)
 4. 12V - 24V Universal FACP Support, auto-current sensing. Support all brands communicating in Contact ID and 4/2

5. Locking Metal Enclosure with Hinged door & 2 key-slots for wall mounting (LED indicators, inside) • Dimensions: 9-5/8" x 11-3/4" x 3-3/8" D (HxWxD) • Weight: 8 lbs (max., power supply models)
 6. Electrical Ratings for 120VAC, 60Hz • For Models with Power Supply: • Input Voltage: 120VAC Nominal • Input Current: 400mA maximum • Maximum Charging Current: 200mA
 7. The Communicators shall each be installed to meet the requirements of NFPA 72, 2013 for Secondary Power as required for Remote Station Supervising Station reporting. The system shall be programmed to report, as required in NFPA 72, 2013 for sole path reporting. The equipment supplier shall provide monitoring by a UL Listed supervising station and include the first-year monitoring fee as part of this contract. This contractor shall wire, connect, and test the operation of the communicators.
 8. Project shall include one years' annual monitoring of the Fire Alarm System. Monitoring shall be provided by a UL listed, approved Central Station. The Central Station shall be approved by the Professional Engineer and authority having jurisdiction and include required daily test reporting.
- J. Supervising Station Signal Transmitter: Provided as part of the system, shall be a Digital Alarm Communications Transmitter (DACT) that is capable of reporting the following signals to a U.L. Listed Supervising Station:
1. Alarm Conditions
 2. Trouble Conditions
 3. Supervisory Conditions
 4. Provide capability to provide additional signals as required by the AHJ.
 5. The DACT shall be installed to meet the requirements of NFPA 72 with 2 telephone line connections, and 24-hour standby power as required for Remote Station Supervising Station reporting. The system shall be programmed to report, as a minimum, every 24 hours to the Supervising Station and shall alternate telephone lines for reporting purposes. Unless otherwise directed by the Building Owner, the equipment supplier shall provide the connections to the supervising station and include the 1st year monitoring fee as part of this contract. The Building Owner shall be responsible making the 2 telephone lines available for connection to the DACT and provide a list of personnel to be contacted by the Supervising Station should the need arise. This contractor shall wire, connect, and test the operation of the DACT.
 6. If the system is certificated as a Central Station system, the battery standby may be reduced to 24 hours of standby power capacity.
 7. Project shall include one years annual monitoring of the Fire Alarm System. Monitoring shall be provided by a UL listed, approved Central Station. The Central Station shall be approved by the Professional Engineer and authority having jurisdiction and include required daily test reporting.
- K. Auxiliary Relays: Provide sufficient SPDT auxiliary relay contacts to provide accessory functions specified. The relay control wiring shall be electrically supervised by the Fire Alarm System to within three feet of the device or equipment to be controlled.
- L. The front panels of all Remote Annunciators shall include Operator controls for ALARM, TROUBLE and SUPERVISORY ACKNOWLEDGE/SILENCE, NOTIFICATION APPLIANCE SILENCING,

NOTIFICATION APPLIANCE RESOUND, and SYSTEM RESET. These operations shall be protected in order that only personnel with equipment keys have access to these functions.

- M. Trouble Sequence of Operation: Any "TROUBLE" condition in the system shall cause the following system operations:
1. Indicate an alphanumeric message on the Main Control Unit and all Remote Annunciators of the specific trouble condition.
 2. Cause an audible trouble signal and "trouble" Lamp or LED to operate on the Main Control Unit and all Remote Annunciators. The audible trouble signal may be silenced, but the visual signal shall remain on until the trouble is corrected, and the system is reset.
 3. Cause a "trouble" signal to be transmitted to the Supervising Station.
- N. Alarm Sequence of Operation: Any "ALARM" condition in the system shall cause the following system operations:
1. Indicate an alphanumeric message on the Main Control Unit and all Remote Annunciators of the specific device that caused the "Alarm" condition
 2. Cause an "Alarm" Lamp or LED to operate on the Main Control Unit and all Remote Annunciators. The "Alarm" lamp or LED shall remain on until the device and system is reset.
 3. Cause all notification appliances in the facility to operate unless the specifications and/or drawings indicate zone or floor control of notification appliances.
 4. Cause an "Alarm" signal to be transmitted to the Supervising Station. The signal shall remain operated until the system is reset at the Main Control Unit or Remote Annunciators.
 5. Operate the following control functions if applicable:
 - a. Elevator recall to main floor and alternate floor as required by the AHJ
 - b. Allow all doors held open by door holders to close depending on the zone in alarm.
 - c. If a duct detector is in alarm, cause its respective air handling unit fan to shut down. The duct detector in alarm shall be programmed as a "supervisory" function per NFPA 90A, unless otherwise required to report as an alarm condition by the local AHJ.
 - d. Any security or access-controlled doors or gates shall be released as required by the local AHJ or Building Owner Representatives.
 - e. Output contact to lighting control panel input to enable selected lighting.
- O. Supervisory Sequence of Operation: Any "SUPERVISORY" condition in the system shall cause the following system operations:
1. Indicate an alphanumeric message on the Main Control Unit and all Remote Annunciators of the specific "Supervisory" condition.
 2. Cause an audible "Supervisory" signal and "Supervisory" Lamp or LED to operate on the Main Control Unit and all Remote Annunciators. The audible "Supervisory" signal may be silenced, but the visual signal shall remain on until the "Supervisory" condition is corrected. Upon correcting the "Supervisory" condition, the "Supervisory" signal shall resound and require acknowledgement. The system can then be reset.
 3. Cause a "Supervisory" signal to be transmitted to the Supervising Station upon activation and the back-to-normal condition.
 4. Supervisory conditions shall include, but not limited to, the following conditions as they apply to this project:

- a. Sprinkler system valve tamper/shutoff and PIV switches
 - b. Sprinkler system fire pump signals (minimum of 3 signals)
 - c. Sprinkler system valve room – low temperature
 - d. Duct detectors, unless directed otherwise by the local AHJ.
 - e. Other conditions as listed in these specifications, shown on the drawings, or as directed by the local AHJ.
- P. Function Switches: Included on Main Control Panel shall be a minimum of 12 manual function switches or pushbuttons that can be programmed to include the items listed below and other functions required in these specifications, shown on the drawings or desired by the Building Owner:
1. System DRILL function
 2. Bypass Supervising Station Alarm Functions ONLY – Trouble and Supervisory conditions shall continue to report to the Supervising Station
 3. Bypass Audible Notification Appliances
 4. Bypass Visual Notification Appliances
 5. Bypass Door Holders
 6. Bypass all Smoke Detectors
 7. through 12 – programmed per the requirements of the specifications, drawings, local AHJ requirements or Building Owner
 8. Operation of any of the above function switches shall cause a “trouble” condition on all Remote Annunciators and cause a report to the Supervising Station. The function switch operation shall be accessible through locked cabinet doors or other acceptable protection to limit access to authorized personnel only.
- Q. Control Equipment Display: All Remote Annunciators shall contain a minimum 80-character alphanumeric display for indicating all system alarm, supervisory, trouble and system functions. A minimum of 32 characters shall be capable of being custom programmed for displaying alarm, supervisory and trouble conditions.
- R. System Record Document Box: A System Record Documents Box shall be provided as follows:
1. The SRD shall be UL Listed and constructed of 18-ga cold rolled steel with a powder coat finish.
 2. The cover shall be permanently screed with 1" high lettering “SYSTEM RECORD DOCUMENTS” with white indelible ink.
 3. The access door shall be locked with a 3/4" barrel lock and there will be a 12" stainless steel piano hinge.
 4. The SRD will have a minimum of 8 gigabyte digital flash memory drive with a slide tab that allows user to select USB-C or Micro USB connector for uploading and downloading information.
 5. The enclosure will supply 4 mounting holes. Inside will accommodate standard 8-1/2" x 11" manuals and document records.
 6. A legend sheet will be attached to the door for system required documentation, key contacts, and system information.
 7. The enclosure shall also provide 2 key ring holders with a location to mount standard business cards for key contact personnel.

- S. Transient Voltage Surge Suppression and Breaker Locks/Labels: Provide on all 120 VAC equipment, control panels, power supplies, etc., the following Transient Voltage Surge Suppression (TVSS) protection, Breaker Locks and Circuit Labels:
1. Space Age Electronics, Inc., part number E120V-GT.
 2. The unit shall be ANSI/ UL listed to standard 1449, 4th edition and will be labeled clearly with indelible ink.
 3. Be attached via the 3/4" rigid coupling, or surface mounted via the 2 external mounting holes.
 4. The unit shall have thermal fuses to protect against fire in short circuit conditions and will have 18" long, 14-ga wires (3x) with a green ground wire.
 5. The enclosure will be a non-dielectric material UL94 QMFZ2/8 grade material providing UV protection.
 6. The unit shall provide visual indication (LED) that unit is protecting and functioning.
 7. The location of each branch circuit disconnecting means shall be permanently identified at the control unit.
 8. System circuit disconnecting means shall be permanently identified as to its purpose in accordance with the following: (1) "FIRE ALARM" for fire alarm systems (2) "EMERGENCY COMMUNICATIONS" for emergency communications systems (3) "FIRE ALARM/ECS" for combination fire alarm and emergency communications systems
 9. For fire alarm and/or signaling systems, the circuit disconnecting means shall have a red marking.
 10. The red marking shall not damage the overcurrent protective devices or obscure the manufacturer's markings.
 11. The circuit disconnecting means shall be accessible only to authorized personnel.
 12. Mechanical Protection. The branch circuit(s) and connections shall be protected against physical damage.
 13. Circuit Breaker Lock. Where a circuit breaker is the disconnecting means, a listed breaker locking device shall be installed.

2.3 MANUAL PULL STATIONS

- A. Description: Addressable single-action pull-lever type with integral addressable module, arranged to communicate manual station status (normal, alarm, or trouble) to the FACP. Fabricated of plastic and finished in red with molded raised-letter operating instructions of contrasting color. Station shall show a visual indication of alarm. UL 38 Listed.
- B. Station Reset: Key or wrench operated switch.
- C. Mounting: Semi-flush (where possible) or surface mounted. Provide manufacturer's standard backbox for surface locations that match the manual station.
- D. Weatherproof Pull Stations: Where indicated or required because the environmental conditions (including temperature and humidity) can become outside the listed ratings of a standard pull station, provide the following:
1. Provide manual pull stations that are suitable for the environment in which they are installed.

2. If a non-addressable device is required, locate an addressable interface module in an accessible location within the listed environmental conditions of the module and as close as possible to the device.
- E. Indoor Protective Shield: Factory fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm.
1. Provide where shown on the Drawings.

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 Indicator: Provide remote indicators as required. All duct smoke detectors installed in concealed spaces shall be provided with a remote indicator consisting of alarm LED installed below the unit in order to facilitate locating the unit for testing and maintenance purposes. Coordinate remote indicator locations with Owner/Engineer before roughing-in.
- D. Weatherproof Enclosures: Where indicated or required provide enclosure complying with NEMA 250 requirements for Type 4X. Where subject to ambient temperatures below the rating of the duct smoke detector, provide insulation, strip heater, power supplies and thermostat.

2.8 PROJECTED BEAM SMOKE DETECTORS

- A. Description: Infrared light obstruction smoke detector consisting of a separate transmitter and receiver or transmitter/receiver and reflector. The beam shall cover an area 30' wide and between 30' and 280' long.
- B. Projected beam smoke detectors shall include the following:
 - 1. Field settable sensitivity settings.
 - 2. Each projected beam smoke detector shall have an associated addressable monitor module to report alarm and trouble conditions to the fire alarm control panel.
 - 3. The detector shall distinguish between smoke and accidental beam blockage. Beam blockage shall report a trouble signal to the fire alarm control panel.
 - 4. The detector shall automatically adjust for ambient influences including dirt and dust.
 - 5. If a reflector is used, it shall be of the size and type as provided by the manufacturer.
- C. Remote Test Stations: Provide remote test stations as required. All projected beam smoke detectors installed in a concealed space shall be provided with a Remote Test Station consisting of alarm LED and test switch installed below the transmitter in order to facilitate locating the unit for testing and maintenance purposes.
- D. Indoor Protective Shield: Factory fabricated wire guard to protect the beam smoke detector from physical damage. UL listed for use with the beam detector.

2.9 MULTI-CRITERIA DETECTOR

- A. Description: Provide an addressable multi-criteria detector with CO sensor that shall support the use of an ambient Carbon Monoxide (CO) warning signal at the panel. This ambient CO level

shall be user-configurable in parts per million (PPM) for the set threshold of the warning and event type generated by the warning. This event can be used to trigger system logic.

- B. The CO sensor may be programmed as part of the multi-criteria detector or may be an independent CO detector.
- C. Each CO detector shall be supplied with a local sounder base that is programmed to activate when CO is detected. This base shall be powered and supervised by the Fire Alarm System in accordance with NFPA 72 and shall be UL listed as a component of the Fire Alarm System and Detector. The sounder base shall be 520Hz if supplied in a sleeping room.

2.10 ADDRESSABLE INTERFACE MODULES

- A. Description: Addressable Interface Modules provide a means of interfacing for monitor or control of non-addressable devices to the fire alarm system. Fire alarm addressable module devices shown on the plans are not intended to indicate quantity, only that the fire alarm interface is required. Provide the quantities of module devices and interface wiring as required to meet NFPA 72 and other applicable code requirements.
- B. Addressable Monitor Modules: Provide means to monitor the status of a normally open or closed contact. Some functions that require addressable monitor modules include:
 - 1. Sprinkler System
 - 2. Kitchen Hood Systems Monitoring
 - 3. Ancillary Fire Protection Systems
 - 4. Knox Box
 - 5. Non-Addressable Devices
- C. Addressable Control Module: Provide means to control equipment using a form C relay consisting of one normally open and one normally closed contact. Contact rating shall be as required for control function. Some functions that require addressable control modules include:
 - 1. Smoke Door Holder Control
 - 2. Air-Handling Unit Control
 - 3. Smoke Control Functions
 - 4. Elevator Controls
 - 5. Security, Access-Controlled Doors and Gates
 - 6. Ancillary Fire Protection Systems
 - 7. Sound System Equipment
- D. Addressable interface modules shall include the following:
 - 1. The interface modules shall be individually addressable and custom programmed for the items they monitor or control
 - 2. The interface module shall mount on a 4" square outlet box and be provided with a faceplate.
 - 3. Each module shall be provided with a label identifying the address and the control or monitor function.
 - 4. Modules shall include a status LED identifying normal condition, unit malfunctioning, and change of state.

2.11 NOTIFICATION APPLIANCES

- A. Description: UL listed **speaker** and visual units for fire alarm notification. **(Addendum 5)**
- B. Combination Units: UL listed **speaker** and visual units as required for application. **(Addendum 5)**
- 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.

2.12 AUDIBLE NOTIFICATION APPLIANCES (SPEAKERS)

- A. **UL 1480 listed fire alarm speakers.**
- B. **Field Selectable Taps: 1/8, 1/4, 1/2, 1, and 2 Watts**
- C. **Field Selectable Taps for large spaces or spaces with high average ambient sound levels: 1/2, 1, 2, 4 and 8 Watts.**
- D. **Audible devices shall meet the requirements of voice intelligibility per NFPA 72.**
- E. **Audible device shall be 520HZ if installed in a sleeping room.**

(Addendum 5)

2.13 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

2.14 KNOX BOX

- A. Provide a flush mounted Knox Box at locations where required by local AHJ, fire marshal, fire chief, etc. and meeting their key requirements. Surface mounted will be acceptable in existing walls. Connect to fire alarm system with a monitor module to provide a supervisory condition.

2.15 REMOTE ANNUNCIATOR

- A. LCD Annunciator:
 - 1. Provide a duplicate annunciator with all functions of the fire alarm control panel including Acknowledge, Silence, and Reset switches. Annunciator shall be capable of monitoring the entire system and full system control.
 - ~~2. Provide a supervised remote microphone with a push-to-talk microphone and operator interface panel. Remote microphone shall be included in the Remote Annunciator Enclosure.~~
 - 2. Provide at locations indicated on the drawings.

(Addendum 5)

- B. Mounting:
 - 1. Flush in new construction or renovated spaces.
 - 2. Surface mounted with matching surface box designed for the unit as indicated or required in existing spaces.

2.16 FIRE ALARM CABLE

- A. Manufacturers:
 - 1. Belden
 - 2. West Pen
 - 3. General
- B. Non-Power-Limited Circuits: Solid copper conductors with 600-V rated, 75°C, color-coded insulation. Wire type and sizes shall be as recommended by manufacturer.
- C. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP. Wire type and sizes shall be as recommended by manufacturer.
- D. All fire alarm cable shall be plenum rated.

2.17 SYSTEM RECORD DOCUMENTS BOX

- A. Space Age Electronics model SSU01690 (System Record Documents Cabinet - Black with your custom screened logo.)
- B. Box shall meet the requirements of NFPA 72 – 7.7.2.1, 7.7.2.4, 7.5.6.7, & 7.2.1.
- C. The SRD System Record Documents Box shall be UL Listed, constructed of 18-ga cold rolled steel and have a powder coat finish.

- D. Dimensions are 12" wide x 13" tall and 2-1/4" deep
- E. The cover shall be permanently screed with 1" high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
- F. The access door shall be locked with a 3/4" barrel lock and there will be a 12" stainless steel piano hinge.
- G. The SRD will have a minimum of 8 gigabyte digital flash memory drive with a slide tab that allows user to select USB-C or Micro USB connector for uploading and downloading information.
- H. The enclosure will supply 4 mounting holes. Inside will accommodate standard 8-1/2" x 11" manuals and document records.
- I. A legend sheet will be attached to the door for system required documentation, key contacts and system information.
- J. The enclosure shall also provide 2 key ring holders with a location to mount standard business cards for key contact personnel.
- K. Provide (1) for the project installed at a location coordinated with the Owner/Architect/Engineer

2.18 FIRE ALARM BREAKER LOCKOUT

- A. Space Age Electronics Model ELOCK-FA (Circuit Lockout Kit).
- B. NFPA 2016 Code Compliance:
 - 1. 10.6.5.2 Circuit Identification and Accessibility
 - 2. 10.6.5.2.1 The location of the branch circuit disconnecting means shall be permanently identified at the control unit
 - 3. 10.6.5.2.2 System circuit disconnecting means shall be permanently identified as to its purpose in accordance with the following:
 - a. (1) "FIRE ALARM" for fire alarm systems
 - b. (2) "EMERGENCY COMMUNICATIONS" for emergency communications systems
 - c. (3) "FIRE ALARM/ECS" for combination fire alarm and emergency communications systems.
 - 4. 10.6.5.2.3 For fire alarm and/or signaling systems, the circuit disconnecting means shall have a red marking.
 - 5. 10.6.5.2.4 The red marking shall not damage the overcurrent protective devices or obscure the manufacturer's markings.
 - 6. 10.6.5.2.5 The circuit disconnecting means shall be accessible only to authorized personnel.
 - 7. 10.6.5.3 Mechanical Protection. The branch circuit(s) and connections shall be protected against physical damage.
 - 8. 10.6.5.4 Circuit Breaker Lock. Where a circuit breaker is the disconnecting means, a listed breaker locking device shall be installed.
- C. Provide (1) for every circuit breaker feeding power to fire alarm panels.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Manufacturer's Installation Requirements: Install products in accordance with manufacturer's instructions and the minimum requirements of the latest edition of the National Electric Code (NEC), NFPA 72 and IBC.
- B. Mounting Heights: All devices shall be mounted at heights indicated below or as otherwise noted on the drawings:
 - 1. Pull stations: 42 to 44" above finished floor to operating handle or lever.
 - 2. Audible and Visual Notification Appliances: 80" to 96" above finished floor.
 - 3. Audible and Visual Notification Appliances-Special Circumstances:
 - a. Multipurpose Room: 96" above finished floor.
 - b. Library: 96" above finished floor but not less than 6" below ceilings and soffits.
- C. Minimum Wire Size: Use 16 AWG minimum size conductors for fire alarm detection and signal circuit conductors.
- D. Color Coded Wires: Provide fire alarm circuit conductors with insulation color coded or use colored tape at each conductor termination and in each junction box. Numbered wires may be substituted for color coded wires. Show numbers or color code on system wiring diagram.
- E. End-of-Line Devices: Mount end-of-line device in box with last device or separate box adjacent to last device in circuit. Indicate the exact location of the end-of-line device on the as-built drawings.
- F. Connections to Auxiliary Devices: Provide conduit and wiring connections to door release devices, door hardware packages, fire suppression system control panels, motorized smoke dampers and security systems.
- G. Trim Rings: Provide trim rings where flush mounted initiating and signaling devices do not completely cover the opening in the wall or ceiling surface.
- H. Telephone Lines: Provide two telephone lines directly to telephone terminal board for direct connections to outside lines for connection of the DACT by the contractor responsible for telecommunications.
- I. New Panel Power: Provide 1P.20A breaker in closest normal panel and connect to main fire alarm panel with 2 #12 + 1 #12 gnd in 3/4" conduit unless otherwise indicated.
- J. Additional panels added by manufacturer: Provide 1P.20A breaker in closest normal panel and connect to additional panel with 2 #10 + 1 #10 gnd in 3/4" conduit unless otherwise indicated.
- K. Provide fire alarm breaker lockout for all circuit breakers feeding fire alarm equipment.
- L. Provide system record document box at location coordinated with Owner/Architect/Engineer.

- M. Interconnection to Lighting Control System: There shall be an interconnection to the Lighting Control System. Provide fire alarm IM relay to initiate dry contact closure on Lighting Control System.
- N. Notification appliances shall meet all applicable codes. Notify the engineer of any problem areas before installation commences. The engineer will review all recommendations for the potential problem areas and advise in writing if additional items or changes are required. Any additional devices required after this point of the project are to be provided at no additional cost to the project.
- O. Measure ambient sound levels once the building is occupied and adjusts audible device tap setting to meet all applicable codes. Tap settings shall be field adjusted to the lowest tap that meets code. Tap settings shall be indicated on the installation and record drawings.
- P. Locate strobe devices at locations indicated on the drawings. A device is only to be relocated if the device is in conflict with casework, equipment, etc. Do not center strobes on walls unless indicated to do so. Set field selectable strobe settings to meet applicable codes. Settings shall be indicated on the installation and record drawings.
- Q. Install automatic detection so it does not exceed the listed spacing and meets the requirements of NFPA 72. Do not locate automatic detection closer than 3' from HVAC grilles.
- R. Install the elevator smoke detectors, heat detectors, and control circuits per NFPA 72 and all applicable codes.
- S. The EC shall furnish the duct smoke detector bases, sampling tubes, and weatherproof enclosures (where applicable) to the MC for installation in/on the ductwork. The EC shall provide the duct smoke detector on the base, fire alarm control relay for AHU shutdown, remote test station (where applicable), and all wiring to/from Fire Alarm Control Panel, duct smoke detector, remote test station, fire alarm control relay, and AHU Controller (for AHU shutdown).

3.2 WIRING METHODS

- A. Wire Routing: Route all device wiring from each device up into ceiling cavity within metallic conduit in recessed or unfinished areas or within surface raceway for renovated non-fishable areas. Stub all conduits into ceiling cavity and provide protective bushing for each.
- B. Cable Routing: Route cable for all device wiring within accessible ceiling cavities. Install in bridle rings at 4' spacing maximum. No cabling is to lie on or attach to ceiling tile, ducts, pipes, conduits or ceiling suspension wires, rods, or structural members. Provide conduit stubs from devices and panels to the ceiling cavities.
- C. Route all fire alarm wiring from fire alarm panel within metallic conduit up into nearby ceiling cavity and connect to the wiring system indicated in A and B above. Provide bushings at conduit ends.
- D. Provide raceways for cabling in all open structure spaces.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 260010.
- B. Acceptance Testing: A 100% Acceptance Test shall be conducted by the Approved Equipment Supplier to meet the requirements of NFPA 72 Chapter 7. The Record of Completion shall indicate the total number of items tested in the system.

3.4 AUTHORIZED EQUIPMENT SUPPLIER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Section 260010.
- B. Include services of certified technician to supervise installation, adjustments, final connections, and system testing as required by local codes.
- C. Program the actual owner-assigned room names/numbers for alarm location indication on displays. System is not considered acceptable with architectural or manufacturer assigned numbers for spaces and devices. In addition, the Equipment Supplier shall reprogram the labels in the system at no charge during the first year of operation as desired by the Building Owner.

3.5 TRAINING

- A. Personnel Training: Provide and pay for the services of a factory-authorized service representative to demonstrate the system and train Owners personnel.
 - 1. Provide training for operating, testing, troubleshooting and general maintenance of the system.
 - 2. Provide a minimum of two, 2-hour sessions with at least 2 weeks advance notice and 2 weeks apart.
 - 3. Provide documentation of sessions to Architect/Engineer with signatures of at least 3 Owners Representatives present at demonstration.

3.6 SEQUENCE OF OPERATIONS

- A. Upon a duct mounted smoke detector alarm condition, the auxiliary relay provided with the smoke detector shall be wired by the electrical contractor to the mechanical equipment's starter and shut down its respective unit. An alarm or trouble signal shall be sent to the fire alarm control panel.
- B. Refer to Section 260180 for interface with elevator.

3.7 TOWNSHIP/FIRE MARSHAL DRAWINGS

- A. The Contractor shall provide CAD Drawings on 11" x 17" sheets showing all device locations with identification numbers attached. These drawings shall show all devices within the building. These drawings shall be turned over to the township representative/fire marshal for their approval.

END OF SECTION 283111

SECTION 283211 – AREA OF RESCUE ASSISTANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all equipment associated with the installation of the Areas of Rescue Assistance System designed for IBC (International Building Code) and ADA (Americans with Disabilities Act) requirements. This work shall include an area of rescue assistance 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 Area of Rescue Assistance 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 AREA OF RESCUE ASSISTANCE 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 VOIP INTERFACE DEVICE

- A. Provide Rath VOIP Interface Device model 2100-VOIP.
- B. Includes one FXS port, one LAN and one WAN port
- C. VoIP Protocols: SIP v2, SDP, RTP and RFC 2833
- D. Network Protocols: IPv4, TCP, UDP, DHCP, SNTP, STUN, HTTP and PPPoE
- E. Connections: FXS RJ11, LAN and WAN RJ45 (10/100 BaseT)
- F. Power: 120vac or 12vdc.
- G. Dimensions: 3.1" W x 4.1" H x 1.1" D.
- H. Power Consumption: 5w
- I. Temp Range: -14°F – 122°F
- J. FCC Part 15 compliant

2.6 AREA OF RESCUE ASSISTANCE 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 for exterior locations.
 - 4. Provide stations at all areas of rescue assistance and 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 AREA OF RESCUE ASSISTANCE 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 area of rescue/refuge or 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 AREA OF RESCUE 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 7090 or 7090D at the entrance to the Area of Rescue Assistance.
 - 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. Interior Tactile Signage:
 - 1. Provide Rath Model 7080 at the entrance to the Area of Rescue Assistance.
 - 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. Exterior Tactile Signage:
 - 1. Provide Rath Model 7086 at the exit to the exterior Area of Rescue Assistance.
 - 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 11" H x 5" W.

2.10 AREA OF REFUGE 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 7050 or 7050D at the entrance to the Area of Refuge.
 - 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. Interior Tactile Signage:
 - 1. Provide Rath Model 7044 at the entrance to the Area of Refuge.
 - 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. Exterior Tactile Signage:
 - 1. Provide Rath Model 7086 at the exit to the exterior Area of Refuge.
 - 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 11" H x 5" W.
- E. Directional Signage
 - 1. Provide Rath Model 7047L or 7047R to direct to the Area of Refuge.
 - 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.

2.11 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 area of rescue assistance 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 area of rescue assistance panel with terminations on both ends.
- J. In renovation projects, cut and patch wall as required to install area of rescue assistance 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. Area of Rescue Assistance Panel: Mount at 60" from floor to center of cabinet. Verify with local code official.
- B. Area of Rescue/Refuge or Elevator Landing 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 Area of Refuge.

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 283211

SECTION 31 00 50 – BASIC SITE MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Soil used for site construction including excavated on-site soil and imported soil materials.
- B. Aggregate materials used for site construction, drainage, and pavement base course.
- C. Bituminous pavement materials used for construction of site access drives, parking areas, walkways and playground areas.
- D. Portland cement concrete materials used for construction of site pavements, slabs on grade, sidewalks, curbing, exterior steps and ramps and minor site structures.
- E. Geosynthetics used in site construction for layer separation, slope and embankment reinforcement, subsurface drainage, and erosion and sedimentation control.
- F. Joint materials used in site construction for premolded expansion joints and joint sealers for rigid site pavements.

1.2 RELATED SECTIONS

- A. Division 1 – General Requirements
- B. Section 31 10 00 – Site Clearing.
- C. Section 31 20 00 – Earth Moving.
- D. Section 32 12 16 - Asphalt Paving
- E. Section 32 13 13 – Concrete Paving
- F. Section 32 92 00 – Turf and Grasses.
- G. Section 33 10 00 - Water Utilities
- H. Section 33 30 00 - Sanitary Sewerage Utilities
- I. Section 33 40 00 – Storm Drainage Utilities.

1.3 RELATED DOCUMENTS

- A. Erosion and Sediment Control Plan and Narrative: Contractor will follow DEP Chapter 102 regulations during construction. Contractor will install controls as described and detailed on the approved plan and narrative. Approved plan and narrative sequences earthwork, installation of storm sewers, inlet protection and temporary control measures as part of storm drainage installation.

1.4 REFERENCES

A. Soil

1. AASHTO T180 – Moisture-Density Relations of Soils Using a 10-lb. Rammer and 18-inch Drop.
2. ASTM D689 – Test Methods for Moisture-Density Relations of Soil-Aggregate Mixtures, Using a 5.5 –lb. Rammer and a 12-inch Drop.
3. ASTM D1556 – Test Method for Density of Soil in Place by the Sand Cone Method.
4. ASTM D1557 – Test Method for Moisture-Density Relations of Soil-Aggregate Mixtures Using a 10-lb. Rammer and an 18-inch Drop.
5. ASTM D2167 – Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
6. ASTM D2487 – Classification of Soils for Engineering Purposes.
7. ASTM D2922 – Test Methods for Density of Soil and SOIL Aggregate in Place by Nuclear Methods (Shallow Depth)
8. ASTM D3017 – Test Method for Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
9. ASTM C136 – Sieve Analysis of Fine and Coarse Aggregates.
10. ASTM D422 – Particle Size Analysis of Soils.

B. Aggregate Materials

1. AASHTO M147 – Materials for Aggregate and Soil-Aggregate.
2. AASHTO T180 – Moisture-Density Relations of Soils Using a 10-lb. Rammer and 18-inch Drop.
3. ASTM C136 – Method for Sieve Analysis of Fine and Coarse Aggregates.
4. ASTM D698 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using a 5.5-lb. Rammer and a 12-inch Drop.
5. ASTM D1557 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using a 10-lb. Rammer and 18-inch Drop.
6. ASTM D2167 – Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
7. ASTM D2487 – Classification of Soils for Engineering Purposes.
8. ASTM D 2922 – Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
9. ASTM D3017 – Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
10. ASTM 4318 – Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
11. Pennsylvania Department of Transportation (PADOT) – Specifications Publication 408,

Latest Edition, as amended.

C. Bituminous Concrete and Bituminous Material

1. Pennsylvania Department of Transportation (PADOT) Specifications Publication, Form 408, Latest Edition, as amended.

D. Portland Cement Concrete Material

1. Pennsylvania Department of Transportation (PADOT) Specifications Publication, Form 408, Latest Edition, as amended.

E. Geosynthetic Material

1. ASTM D751 – Standard Test Method for Coated Fabrics.
2. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
3. ASTM D4595 – Tensile Properties of Geotextiles by the Wide-Width Strip Method.
4. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
5. ASTM D 7176 - Non-reinforced Polyvinyl Chloride (PVC) geomembrane for direct burial

F. Joint Materials and Joint Sealants

1. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
2. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
3. ASTM D1752 – Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction, Sections 5.1 through 5.4 with the compression requirement modified to 10 psi minimum and 25 psi maximum.

1.5 SUBMITTALS FOR REVIEW

A. Submittal procedure as specified in Division 1.

B. Soil Submittals:

1. Soil Test Reports and Certification: Submit One (1) soil sample from each off-site borrow source of clean earth fill and topsoil material to an approved, independent analytical testing laboratory retained by the Contractor and approved by District.
 - a. Two (2) copies of certified test results shall be submitted to the District for approval prior to delivery of any soil to the site. Soil will be considered acceptable if it meets the minimum physical parameter requirements specified and if inorganic constituents are within the typical range of Eastern U.S. soils, and if synthetic organic compounds are below detection limits.

- b. In lieu of the analytical sampling requirements, District will accept two (2) copies of certified test results from a recent sampling event, or a certification from the borrow source that the material is virgin, uncontaminated material.

C. Aggregate Submittals:

1. Aggregate Samples: Submit aggregate samples for each classification representative of material source to District.
2. Aggregate Test Reports and Certification: Submit test reports from aggregate supplier indicating material meets the specified requirements or certification that gradation of aggregate is certified by the Pennsylvania Department of Transportation for each aggregate classification.

D. Bituminous Concrete and Bituminous Material Submittals:

1. Submit certification from materials source indicating that materials are certified by the Pennsylvania Department of Transportation for each bituminous mix.

E. Portland Cement Concrete Material Submittals:

1. Material Certificates: Provide material certificates certifying that concrete materials for each designation meets, or exceeds, specified requirements.
2. Submittal procedure as specified in Division 1.

F. Geosynthetic Material Submittals:

1. Submit representative samples of all geosynthetic proposed for use, including manufacturer's name, designation, and installation instructions.
2. Submit detailed drawings, as prepared by the manufacturer, or contractor, indicating the method of overlapping, joining, and anchoring of geosynthetic materials for each application.

G. Joint Material and Sealant Submittals:

1. Product Data: Submit product data for expansion joint filler and joint sealants indicating material meets, or exceeds, specified requirements.

1.6 SUBMITTALS FOR INFORMATION

- A. Submittal procedure as specified in Division 1.
- B. Materials Source: Submit name of imported material source and location for all soil material and aggregates.
- C. Topsoil Test Results: Submit laboratory test results for on-site and imported topsoil materials indicating analysis and recommendations for soil amendments to sustain growth for each seed mix, sod mix, and for trees, shrubs, and ground covers. Analysis shall include testing of the specific criteria specified in Section 32920. A minimum of one (1) sample shall be submitted to

the testing agency per five (5) acres of ground disturbance to determine if any variations exist in the topsoil characteristics.

1.7 SOURCE QUALITY CONTROL

- A. Section 01400 – Quality Requirements
- B. Testing and Analysis of Soil: Soil shall require advanced examination according to the methods referenced. The Contractor's certified laboratory or borrow source shall provide the District with test results a minimum of two weeks prior to delivery of off-site borrow materials for use in site construction. The testing laboratory shall furnish both the District and Contractor required copies of the test reports. The reports will be considered as sufficient information to accept or reject the proposed imported soil.
- C. If the indicated soils do not meet specified requirements, change material and retest.
- D. Provide soil and aggregate materials of each designation from same source throughout the Work.
- E. Provide aggregate from PADOT approved source based upon latest PADOT Bulletin.
- F. Moisture content for any soil or aggregate material to be used for compacted fill in structural or non-structural areas shall not exceed a range of plus or minus 3.0 percent of optimum moisture content for that particular material. If the moisture contents fall outside of this range appropriate aeration or moisture conditioning measures shall be performed by the Contractor to maintain soil moisture contents within the specified range.

PART 2 - PRODUCTS

2.1 SOIL

- A. Definitions:
 - 1. Structural Fill Zone:
 - a. All areas of bulk fill necessary for building construction, slabs on grade, rigid pavement, flexible pavements, retaining walls, detention basin berms, embankment construction, and buffer zones.
 - b. All backfill located within the Structural Fill Zone, foundation wall backfill, and retaining wall backfill, and exterior perimeter of wall backfill zones.
 - c. All utility trenches in any location.
 - 2. Nonstructural Fill Zone: All bulk fills necessary for establishing finished subgrade of areas not scheduled for site improvements, pavements, or structures.
 - 3. Bulk Fill: All activities, placement of soil materials, compaction, and other work as required to raise the existing site elevation to the finished subgrade elevation.
 - 4. Backfill: All activities, placement of soil materials, compaction, and other work as required to fill voids and excavations in native in-place soils or bulk fills to the finished subgrade elevation.
 - 5. Trench Fill: All activities and placement of soil or aggregate material from the initial trench backfill to the required subgrade elevation.

6. Buffer Area: Area extending 10-feet beyond the perimeter of any building foundation line, including any areas of future expansion indicated on the Drawings, and 10-feet beyond the perimeter of all other Structural Fill Zones.
7. Soil Materials: Inorganic on-site or imported earth as further described in 310050, 2.1.B below.
8. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
9. Subbase Course: Aggregate layer placed between the subgrade and binder course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
10. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
11. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

B. Soil Materials

1. Bulk Fill and Backfill Material:
 - a. Structural and Non-Structural Fill Zone: Inorganic uniformly graded on-site soils with a maximum particle size of four-inches and of suitable moisture content. To the extent that on-site material meets the requirements, such material may be used as fill. Provide Imported or Engineered Fill required to complete the Work due to insufficient quantity of existing on-site material or unsuitability of existing on-site soil.
 - b. Satisfactory Soils: Soil Classification Groups CL, GW, GP, GM, ML, SW, SP, and SM according to ASTM D 2487, Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than four (4) inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Liquid Limit: 40, Plasticity Index: 10.
 - c. Unsatisfactory Soils: Soil Classification [Groups GC, SC, OL, CH, MH, OH, and PT according to ASTM D 2487] [Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145], or a combination of these groups. Unsatisfactory soils also include satisfactory soils not within 2 percent of optimum moisture content at time of compaction and any regulated, hazardous, contaminated, petroleum-impacted, or otherwise unsatisfactory soils or materials encountered within the project limits. If such materials are encountered, all associated testing, characterization, handling, transportation, disposal, remediation, and related costs will be paid for separately.
2. Imported Fill: Inorganic well-graded materials with 100-percent of the soil material passing a two-inch mesh sieve, and no more than 10-percent passing a 200-mesh sieve. Liquid limit shall not exceed 40 with a maximum plasticity index of 10. Use of slag is not permitted.
3. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
4. Trench Fill Material: Inorganic on-site soils with a maximum particle size of four inches and of suitable moisture content.

- a. Bedding, haunching, and initial backfill material shall be in accordance with Drawings and Specifications for the type of utility and utility pipe material.
 - b. Conform to municipal authorities, public utility companies, and other agencies having jurisdiction for Utility Trench Backfill Material for public utilities or utility trenches located within the public right-of-way.
5. Clay: Soil that classifies as CH or CL in accordance with ASTM D2487. Clay shall have a Liquid Limit (LL) between 30 and 50 and a Plasticity Index (PI) between 10 and 15, as per ASTM 4318. The clay shall be able to be compacted to the required density specified herein with an associated permeability of 1×10^{-7} cm/sec or less according to ASTM D5084.
6. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles no larger than one-half (1/2) of an inch in diameter; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of clay lumps, gravel, and other objects; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.
7. All imported materials must be obtained from approved borrow sources.

2.2 AGGREGATE MATERIALS

- A. Aggregate material used in site construction shall meet the requirements of PADOT Publication 408, latest edition.
- B. Subbase Course (Cement Concrete Pavements, Stairs, Slabs and Curbing) : AASHTO #57 open graded aggregate or as otherwise indicated on the Drawings.
- C. Bituminous Paving: PA DOT 2A aggregate or as otherwise indicated on the Drawings.

2.3 BITUMINOUS CONCRETE AND BITUMINOUS MATERIAL

- A. Bituminous concrete and bituminous materials shall meet the requirements of PADOT Publication 408.
- B. Bituminous pavement materials used in site construction shall be as specified on the Drawings.
- C. Bituminous Materials:
 1. Asphaltic Cement: Class AC-20, conforming to PADOT Publication 408, 702.1.
 2. Bituminous Tack Coat: Emulsified Asphalt conforming to PADOT Publication 408, 460.2.
 3. Bituminous Prime Coat: Cut-back petroleum asphalt class MC-30, conforming to PADOT Publication 408, Section 461.2.

2.4 PORTLAND CEMENT AND CONCRETE MATERIALS

- A. Concrete material used in site construction shall meet the requirements of PADOT Publication 408 with a Water/Cement Ratio of 0.40.

- B. Performance Requirements: Concrete material for cast-in-place and poured in-place site construction shall meet or exceed the following requirements for cement concrete as specified in PADOT Publication 408. Furnish class of concrete as follows:

PADOT Class	Site Use	28 Day Mix Design Compressive Strength (psi)
A	Vertical, Slant, and Depressed Curb, Trench Drain Concrete Encasement	3,500
A	Concrete Sidewalk	4,000
A	Concrete Steps / Ramps	4,000
A	Concrete Walls and Footers	4,000
A	Concrete Slabs	4,000
A	Anti-Seep Collars	3,500
A	Fence, Sign Post, Play Equipment Footers	3,500

- C. Concrete Sealant: As specified in Section 32 13 13.

2.5 GEOSYNTHETIC MATERIAL

A. Geotextiles

1. Erosion Control: Geotextile fabrics for erosion control shall be a machine fabric mat sewn together with polypropylene netting. Specification includes both photodegradable thread and UV treated threads for permanent/semi-permanent erosion control blankets. Specified manufacturer and product as indicated on the Drawings shall be considered the minimum standard for alternate materials.
2. Separation/Stabilization Fabric: Geotextile fabrics used in site construction to separate subgrade from aggregate or soil fill courses and for subgrade stabilization shall be a spunbound woven or non-woven geotextile fabric as specified. Specified manufacturer and product as indicated on the Drawings shall be considered the minimum standard for alternate materials.
3. Drainage/Separation: Geotextile fabric used in site construction as part of subdrainage systems shall be non-woven, spunbound geotextile fabric. Mirafi 140N non-woven, polypropylene geotextile shall be considered the minimum standard for alternate materials.

2.6 JOINT MATERIAL

- A. Joint materials used in site construction includes premolded expansion joint filler material, isolation joint filler material, joint backing material, and joint sealing material for expansion/contraction joints in rigid concrete paving.
- B. Expansion/Contraction Joint Filler Material:

1. Asphalt: Self-sealing blend of asphalts, fibers, and mineral fillers formed between asphalt-saturated liners meeting the requirements of ASTM D994, Sealtight Asphalt Expansion Joint Filler as supplied by W.R. Meadows, Inc. (800-342-5976), or approved equal.
 2. Fiber: Non-extruding cellular fibers uniformly saturated with asphalt meeting the requirements of ASTM D1751, Sealtight Fibre Expansion Joint as supplied by W.R. Meadows, Inc. or approved equal.
 3. Foam: Closed cell, non-absorbent blend of isomeric polymers meeting the requirements of ASTM 1752, Sections 5.1 through 5.4 with the compression requirement modified to 10 psi minimum and 25 psi maximum, Sealtight Ceramar Flexible Foam Expansion Joint Filler as supplied by W.R. Meadows, Inc., or approved equal.
 4. Cork and Self-Expanding Cork: Not Used.
 5. Sponge Rubber Type: Not Used.
- C. Joint Sealant Material:
1. Concrete Curb Expansion Joint Sealant: Cold applied rubberized, gun grade, single component sealing compound meeting the requirements of ASTM D 1850 as supplied by W.R. Meadows, Inc., or approved equal.
 2. Concrete Sidewalk, Stair, Slab, and Curb Expansion Joint Sealant: Two-component, premium grade, polyurethane-based, elastomeric, self-leveling sealing compound meeting the requirements of ASTM C920, Type M, Grade P, Class 25. Pouthane, as supplied by W.R. Meadows, Inc., Sikaflex-2c, as supplied by Sika Corporation (610-437-5096), or approved equal. Colored sealant to be Lithoseal Trafficalk-3G as manufactured by L. M. Scofield Company, Douglasville, Georgia or approved equal. Provide standard manufacturer's color chart for selection by District. Provide custom colors to match tinted and stained concrete paving as selected by District. Color selection shall be equal to L. M. Scofield Company Standard and color selection chart.
- D. Accessories:
1. Joint Cleaner: Non-corrosive and non-staining compatible with joint filler material as recommended by manufacturer.
 2. Primer: Non-staining as recommended by manufacturer.
 3. Joint Backing: Round, closed cell polyethylene foam rod, oversized 30 to 50 percent of joint width, meeting the requirements of ASTM D1056.
 4. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer.

PART 3 - EXECUTION

3.1 MANUFACTURER'S SPECIFICATIONS AND INSTRUCTIONS

- A. Install products and materials in accordance with manufacturer's instructions, project drawings/details and as directed by specification Sections utilizing materials specified in this Section.

3.2 SOIL AND AGGREGATE STOCKPILES

- A. Stockpile soil and aggregate materials on site at locations approved by the Owner.

1. Stockpile material in sufficient quantities to meet the Project schedule and requirements of the Work.
2. Separate differing materials with dividers or stockpile apart to prevent mixing.
3. Direct surface water away from stockpile to prevent erosion. Stabilize stockpiles in accordance with Erosion and Sediment Control Plan or as directed by County Conservation District.
4. Stockpiles shall be ramped and rolled with a vibratory roller and covered with plastic to prevent soils from becoming saturated. No consideration will be given to unsuitable moisture content of soils not protected from weather conditions.
5. Remove surplus stockpiled material from site and restore to original or design condition. Final grade to prevent free standing surface water.

END OF SECTION

SECTION 31 10 00 – SITE CLEARING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Subsurface Investigation: Test pits to determine location of underground site utilities.
- B. Selective site demolition of structures and utilities at grade, below grade, and above grade.
- C. Clearing and grubbing, selective clearing, and selective tree removal and trimming.
- D. Stripping and stockpiling of topsoil.
- E. Temporary support of structures and earth to protect existing or new construction.
- F. Temporary Erosions and Sedimentation Control measures.
- G. Contractor staging, storage, and field office areas.

1.2 RELATED SECTIONS

- A. Division 1 – General Requirements
- B. Section 31 00 50 – Basic Site Materials and Methods: Topsoil and backfill materials.
- C. Section 31 20 00 – Earthwork: Excavating around and protection of existing utilities and structures to remain; backfilling voids and excavations created by demolition.
- D. Section 32 92 00– Turf and Grasses – Temporary Lawn Restoration/Erosion Control

1.3 REGULATORY REQUIREMENTS

- A. Conform to local regulations and codes for disposal of debris. Hazardous or contaminated materials, as defined by Federal and State regulations or by documents provided by the Owner, shall be disposed of at permitted sites.
- B. Verify that Owner has obtained an Erosion Control Permit prior to initiating any earthmoving activities as defined by PADEP Chapter 102.
 - 1. Review Erosion and Sediment Control Plan and Permit requirements. Coordinate meeting, if required by Permit requirements, with appropriate regulatory agencies prior to initiating Work.
- C. Burning or burying brush, trees, and other materials is not permitted.

- D. Conduct Work to ensure minimum interference with roads, streets, walks, and other structures or facilities. Do not close or obstruct streets, walks, or other occupied facilities without permission from authorities having jurisdiction. Employ traffic on site in accordance with Owner's requirements. Employ traffic control measures when working on or along public roadway corridors in accordance with PADOT, Title 67, Chapter 203, when applicable.
- E. Conform to OSHA CFR, Part 26, Subpart B – Construction Standards for excavation for all excavations.
- F. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site in accordance with all Federal, State and Local laws and ordinances.

1.4 SUBMITTALS FOR REVIEW

- A. Submittal procedure as specified in Division 1.
- B. Submit plan showing location and approximate size of Contractor staging, parking, and field office area. Indicate materials to be used to stabilize temporary parking, staging and field office areas where stabilization will be required.
- C. Contractor shall submit a plan when shoring, bracing, or other structural support of existing buildings or structures is required. The plan shall be prepared and sealed by a Professional Engineer registered in the Commonwealth of Pennsylvania.

1.5 PRE-CLEARING MEETING

- A. Field mark all individual trees outside of clearing and grubbing limits designated on Drawings to be removed a minimum of two-weeks prior to initiating clearing operations.
- B. Notify Owner after individual trees have been marked and limits of clearing have been field identified.
- C. Arrange meeting with Owner, or Owner's representative, to review clearing and tree removal prior to initiating clearing operations.

1.6 SHORING, BRACING, AND UNDERPINNING

- A. Protect all existing utilities, structures, and Work during project, including foundation grouting, sheet piling, shoring, bracing, slab jacking, soil stabilization, and underpinning when working adjacent to existing utilities or structures.
- B. Perform shoring and bracing in accordance with OSHA requirements when excavating.
- C. Review all shoring, bracing, and structure protection operations with District prior to beginning the Work.

- D. Repair damage, slumping, or collapse due to removal of supporting soils, aggregates, existing in-place retaining or support structures due to failure to provide appropriate protection of existing structures and facilities.

1.7 QUALIFICATIONS

- A. Assign design, supervision, and maintenance of all structure protection devices to qualified construction specialist.
- B. Assign, or retain, qualified arborist, landscape District, or equal professional, supervision for pruning existing trees to remain and removal of trees in close proximity to existing trees to remain.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Temporary Construction Fence:
 - 1. Tree Protection Fence: Undamaged, four feet high, with steel u-channel stakes or commercially available weather resistant fencing. Use only orange or yellow construction fencing when barricading open excavations.
 - 2. Temporary Chain Link Fence: Undamaged, 6-feet high, new or used galvanized chain link fence and accessories excluding any requirements for top rails or bottom rails.
 - a. Temporary chain link fence may be movable fence sections utilizing base plates anchored with sandbags or other methods to resist displacement.
- B. Backfill Materials:
 - 1. Voids where groundwater is not present: Soil Backfill.
 - 2. Voids where groundwater, wet soils, or springs are present: As directed by the Owner's Geotechnical Representative.
- C. Herbicide: Commercially available as required to inhibit stump growth, compatible with final seeding and landscaping, and non-damaging to existing vegetation or landscaping to remain.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Protect improvements on adjoining properties and Owner's property designated to remain. Provide temporary fencing to the limits indicated on the Demolition Plans for and as required to define or control site access and separate construction activities for Owner's use of site.

- B. Identify and protect above ground and below ground utilities to remain from damage. Provide protective measures necessary and as required by public utility companies to maintain uninterrupted service.
- C. Protect trees, shrubs and plant growth to remain as final landscaping. Erect tree protection fencing around specimen trees and landscaping designated to remain.
 - 1. Critical Root Zone (CRZ): Avoid compacting, excavating, or damaging the Critical Root Zone of all existing trees to remain. The Critical Root Zone is equal to one foot of radius for each one-inch of tree caliper or 100-percent of the tree canopy, whichever is greater.
 - a. Replace any existing tree designated to remain damaged by unauthorized operations within the Critical Root Zone with same species tree with caliper equal to 1/3 of the caliper of the damaged tree.
 - 2. Install tree protection fencing along the perimeter of Critical Root Zone. Maintain fencing until final landscaping or other Work requires removal.
- D. Protect benchmarks, property markers, monuments, and existing site structures designated to remain.
- E. Replace existing trees, shrubs, plants and replace or repair site pavement and structures that are damaged by the Work. Restore damaged structures to their original or better condition as acceptable to parties having jurisdiction.

3.2 COORDINATION

- A. General: Coordinate clearing and demolition Work in accordance with the phasing for the project.
- B. Utility Services: Coordinate demolition of utility services with installation of temporary utilities, services, and pipe lines where required. Do not remove required utilities until temporary utilities, or new Work, has been installed to provide uninterrupted service.

3.3 PREPARATION

- A. Field identify limits of clearing. Notify District two weeks prior to beginning clearing operations to permit field review of clearing limits and tagging of trees to remain along clearing perimeter.
- B. Verify that existing plant life to remain is tagged and identified.
- C. Identify a waste area and salvage area for placing removed materials.
- D. In accordance with the project phasing, the Contractor shall identify and field delineate limits of pavement removal and partial removal of other site structures and paving.

- E. Verify that all underground utilities have been located in the area of the Work and that all utility companies having jurisdiction have been properly notified in advance of any excavation Work.
- F. Obtain all permits and other approvals required for demolition of buildings, utilities, and site structures where required.

3.4 TEST PITS

- A. Contractor shall be responsible for verifying the depth of existing charted utilities in project area prior to construction.
- B. Test pit locations are required to verify intended design of new utility connections to existing utilities or depth below grade of existing utilities that may be affected by removal or excavation of soil cover during construction. Excavate to uncover utility line in accordance with Section 312000.
- C. Backfill all test pits after the required information has been obtained and only after field inspection by the District.
 - 1. When District requests field inspection, barricade the open excavation to prevent accidental encroachment until the field inspection is completed and backfilling authorized.
 - 2. Where District authorizes backfilling without field inspection, immediately backfill excavation in accordance with Section 312000.
 - a. The District may waive the compaction requirements when the excavation will be reopened for additional Work. Excavation may remain open for a maximum of two-days if Work requiring the uncovered utility will begin within that time. All open excavations shall be barricaded.

3.5 CLEARING, GRUBBING, AND TREE REMOVAL

- A. Erosions and Sedimentation Control Facilities:
 - 1. Do not perform clearing operations until erosion and sediment control facilities are in place. Limit initial clearing to only those areas required for installation of erosion and sediment controls.
 - 2. The Contractor shall be responsible for maintaining all erosion control in accordance with the approved plan and any cited violations by the local Conservation District. All violations must be brought to the Owners attention and be immediately addressed by the appropriate Contractor to avoid any potential delays in the project schedule.
- B. Clearing and Grubbing: Clearing and Grubbing includes the complete removal of all trees, shrubs, brush and existing ground cover.

1. Perform operations in accordance with regulations pertaining to tree removal and erosion and sedimentation control plans.
 2. Clear and grub all areas designated on the Drawings and as required to complete the Work.
- C. Individual Tree Removal: Individual Tree Removal includes the removal of all trees designated on the Drawings.
1. Individual Tree Removal and shall be performed in a manner that does not damage existing trees or designated plant growth to remain.
 2. Do not remove trees with overlapping canopies where one or more tree is designated to remain prior to reviewing procedures with District.
 3. Treat all exposed cuts of trees limbed as part of Selective Tree Removal and Trimming operations to prevent disease and insect damage.
- D. Stump Removal:
1. General Lawn Areas: Completely remove all stumps and root systems to a minimum depth of 12-inches below finished grade.
 2. Roadway, Paved, and Structural Areas: Completely remove all stumps and root systems.
 3. Landscape Areas: Completely remove all stumps and root systems.
- E. Disposal of Trees, Shrubs, and Brush: Remove all trees, shrubs, brush, and vegetated material waste resulting from clearing Work from Site.

3.6 SITE DEMOLITION

- A. Miscellaneous Site Improvements: Perform all Work as required to remove or relocate designated site improvements. Removal includes all areas, parts, surfaces, and apparatus located above the surface and any portion of the structure and associated improvements located below grade. Relocation to on-site location as directed by Owner.
1. The Contractor shall exercise care to prevent damage to site improvements specified to be salvaged and stored or reinstalled. To avoid disputes, document condition and any existing damage to site structures for salvage prior to removal.
 2. All site structures removed as part of the Work shall be properly disposed of off-site.
- B. Utilities: Perform all Work as required to remove existing designated site utilities. Removal includes all pipe, conduit, valves, appurtenances, inlets, and manholes associated with the utility unless designated otherwise to remain as part of the Work or to be abandoned in place.
1. Where partial removal is proposed for later connection or realignment, Contractor shall temporarily plug open end of utility until connection is ready to be made. Where a piped utility has been partially removed and the remaining piped utility will be abandoned, the open of the pipe shall be permanently plugged with concrete or using a standard manufacturers end cap or plug.

2. The Contractor shall notify all public utility companies prior to removing, capping, plugging, or abandoning any public utility or public utility service connection. All work regarding public utility lines shall be performed in accordance with the utility company having jurisdiction. The Contractor shall be responsible for all costs associated with relocating existing utilities.
 3. Accurately locate all abandoned utility lines on the project record drawings and note any utility lines that have been removed.
- C. Items for Salvage: No right of property is granted to any materials or structures removed as part of site demolition. Notify District prior to removal of salvageable site structures.
1. Schedule of Site Items for Salvage: Not Required.
 2. Break loose and remove any footings from items indicated for salvage. Where a footing cannot be removed, or an item designated for salvage cannot be removed without cutting or damage to the item, notify District.
 3. Designate area for storage of salvage items that will not interfere with Work.

3.7 TOPSOIL STRIPPING AND STOCKPILING

- A. Topsoil stripping includes removal of the existing topsoil from areas to be further excavated or regraded.
- B. Do not mix in foreign materials or subsoil when excavating topsoil. Do not excavate wet topsoil.
- C. Stockpile topsoil on-site and protect from erosion in accordance with the Erosion and Sediment Control Plan.
- D. Remove excess soil not intended for reuse from the site.

3.8 CONTRACTOR PARKING, STAGING, STORAGE, AND FIELD OFFICES

- A. Locate staging, storage, and field office area to minimize interference with Owner's use of site, existing site vehicular traffic, and pedestrian traffic.
- B. Access: Access to construction parking, staging and storage areas shall only be at approved locations.

END OF SECTION

SECTION 31 20 00 – EARTH MOVING

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Protection of existing site structures, utilities, and property.
- B. General filling and backfilling, including moisture control, compaction, testing and field quality control.
- C. Preparing subgrade for the synthetic turf athletics fields.
- D. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses.
- E. Excavating and backfilling for buildings and structures.
- F. General excavating, including dewatering and rock removal.
- G. Trench excavation for utilities unless indicated otherwise on the Drawings.
- H. Rough grading, placement of topsoil, and finished grading.

1.2 RELATED SECTIONS

- A. Division 1 – General Requirements
- B. Division 2 – Selective Structure Demolition
- C. Division 3 – Concrete.
- D. Section 31 00 50 – Basic Site Materials and Methods: Soil and geosynthetic materials used in earthwork construction.
- E. Section 31 10 00 – Site Clearing.
- F. Section 32 12 16 – Asphalt Paving
- G. Section 32 13 13 – Concrete Paving
- H. Section 32 18 13 – Synthetic Turf Athletic Field
- I. Section 32 92 00 – Turf and Grasses
- J. Section 33 10 00 - Water Utilities

K. Section 33 30 00 - Sanitary Sewerage Utilities

L. Section 33 40 00 – Storm Drainage Utility.

1.3 RELATED DOCUMENTS

- A. Erosion and Sediment Control Plan and Narrative: All Prime Contractor's performing excavation will follow DEP Chapter 102 regulations during construction and be responsible for correcting any violations cited by the local Conservation District. Contractor will install controls as described and detailed on the approved plan and narrative. Approved plan and narrative sequences earthwork, installation of storm sewers, inlet protection and temporary control measures as part of storm drainage installation.

1.4 REFERENCES

- A. ASTM D698 and ASTM D-1557 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures.
- B. ASTM D1556 – Test Method for Density of Soil in Place by the Sand cone Method.
- C. ASTM D2216 – Laboratory Determination of Moisture Content of Soil.
- D. ASTM D2487 – Classification of Soils for Engineering Purposes.
- E. ASTM D2922 – Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- F. ASTM D3017 – Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- G. ASTM D4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- H. OSHA 29 CFR, Part 26, Subpart B – Construction Standards for Excavation.

1.5 SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
1. Geotextiles.
 2. Warning tapes.
- B. Samples for Verification: For the following products, in sizes indicated below:
1. Geotextile: 12 by 12 inches.
 2. Warning Tape: 12 inches long; of each color.
- C. Qualification Data: For qualified testing agency.
- D. Blasting plan approved by authorities having jurisdiction.

- E. Seismic survey report from seismic survey agency, if blasting is proposed.
- F. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.6 QUALITY ASSURANCE

- A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:
 - 1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
 - 2. Seismographic monitoring during blasting operations.
 - 3. Schedule must be coordinated with District and current school schedules and scheduled during off-peak times.
- B. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
 - 1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
 - 2. Seismographic monitoring during blasting operations for buildings/structures located within ¼ mile of blasting location.
- C. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.7 PROTECTION AND RESTORATION OF PROPERTY AND UTILITIES

- A. Existing walks, fences, roads, buildings, structures and other site features in or adjacent to the project work area shall be protected during the Work by placing barricades, fencing, or other suitable means as approved by the District.
- B. All excavation equipment and other machinery shall be operated with care to prevent damage to existing structures designated to remain and to new construction.
- C. Tractors, bulldozers, and other equipment shall not be operated on existing or newly paved surfaces unless approved by the Owner. Material storage areas and staging areas shall be established as indicated on the Drawings so as not to damage the pavement.
- D. All lawns, paved surfaces, curbing, sidewalks, and other structures that are damaged through the Contractor's operations shall be restored to a condition equal or better than they were found prior to the beginning of the Work at no expense to the Owner. Restoration work shall be completed as promptly as possible following observation of any damage or destruction.

- E. Contractor shall notify all utility companies, pipeline companies, and the Owner to assist in determining the location and protection procedures for utility services and pipelines prior to construction. The Contractor shall be responsible for obtaining and implementing any protection requirements for existing utilities as may be required by the utility company. Underground utilities have been located on the Drawings based upon field survey of surface appurtenances, Owner's drawings, and in accordance with Act 187 of 1996. Utility information indicated on the Drawings shall be considered approximate and is provided to advise the Contractor where possible obstructions exist and as to the extent to which these may affect construction. As excavation approaches pipes, conduits, or other underground utilities, manual methods of excavating shall be employed around buried utilities. Where materials cannot be removed by manual methods, the Contractor shall immediately notify the District. No additional compensation will be provided for manual excavation around known existing utilities.
- F. The Contractor shall be responsible for all costs including repair, replacement, fines, fees, and penalties, for damage to any existing known utility services. Utility services include phone, CATV, electric, gas, water, sanitary sewer, petroleum, process lines, storm sewers, and all other public and private utilities. Should uncharted, or incorrectly charted, piping, conduit, ducts, or utilities be encountered during excavation, the Contractor shall immediately notify the District and the utility company for direction and shall cooperate with the Owner and the utility company as to maintain existing services and facilities in operation. Upon discovery of an uncharted utility, the utility from that time forward shall be considered as a known utility and the Contractor will be responsible for any costs associated with additional damage.
- G. If any piping, conduits, ducts, or utilities are damaged during the process of the excavation, immediately begin to make emergency repairs and notify the proper authorities or persons. Repair damaged utilities to the satisfaction of the utility owner and District. To prevent dispute as to the cause of damages, Contractor shall carefully note and properly report such damage.
- H. Where Work will require crossing, excavation over, or connection to existing utility service, the Contractor shall excavate a test pit to accurately determine the elevation and alignment of the existing utility. The Contractor shall immediately provide this information to the District. Test pits to determine utility existing utility information shall be provided to the District a minimum of three days prior to commencing with the affected portion of the Work unless approved otherwise. The Contractor is responsible for damage to any existing known utility as a result of test pit excavation and no additional compensation will be provided for manually excavating test pits.

1.8 SUBSURFACE CONDITIONS

- A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
 - a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
 2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. 6 inches beneath bottom of concrete slabs on grade.
 - e. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42-inches wide.
 - f. 24-inches below underground stormwater management beds.
- B. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. Yd for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-(1065-mm-) wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom; measured according to SAE J-1179.
 2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp(172-kW) flywheel power and developing a minimum of 47,992-lbf(213.3-kN) breakout force with a general-purpose bare bucket; measured according to SAE J-732.
- C. Excavation: Removal of material encountered above and to design subgrade elevations.
- D. Additional Excavation: Excavation below design subgrade elevations as directed by District. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- E. Bulk Excavation: Excavations more than 10 feet in width and pits more than 30 feet in either length or width.
- F. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by District. Unauthorized excavation, as well as remedial work directed by District, shall be executed without additional compensation.

- G. Unclassified Excavation (Alternate Bid Item): Work described in this section shall be executed to design subgrade regardless of the nature of subsurface materials encountered. The Contractor shall immediately notify the District upon discovery of unforeseen or unsuitable subsurface conditions, underground storage tanks, contaminated soils, buried debris, tree stumps, or rubbish. As unclassified excavation, no additional compensation is made for difficulties occurring in excavation and handling of materials to design subgrade. When encountered, remove rock to lines and subgrade elevations indicated below to permit installation of permanent construction without exceeding the following dimensions. These dimensions shall be considered design subgrade elevation.
1. 24 inches outside of concrete forms other than at footings.
 2. 12 inches outside of concrete forms at footings.
 3. 6 inches outside of minimum required dimensions of concrete cast against grade.
 4. 6 inches beneath bottom of concrete slabs on grade.
 5. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.
 6. 24-inches below underground detention/infiltration bed.

1.9 SURVEY LINES AND MARKERS

- A. Contractor shall establish all baselines and survey control required for the Work. All existing property line markers, monuments, control points, shall be protected or otherwise replaced by the Contractor. All property line markers, when disturbed or dislodged, shall be reset by a professional licensed surveyor. All known survey points, control points, benchmarks, and vertical control datum is indicated on the Drawings.
- B. Contractor shall verify that the survey benchmark and intended elevations for the Work are as indicated. Contractor shall set additional horizontal and vertical control points as required to execute the Work.

1.10 COORDINATION

- A. Coordinate all Work under the provisions of Division 1 as to avoid conflict with other operations and Owner's use of site.

1.11 PROJECT RECORD DOCUMENTS

- A. Submit record documents under the provisions of Division 1.
- B. Accurately record actual locations, size and type of all utilities, including but not limited to storm sewers, water lines, sanitary sewer lines, conduits, fiber optic, electric lines, phone lines, CATV lines, and transmission lines by horizontal location and elevation of inverts at all structures for storm sewer and sanitary sewer lines. Meet or exceed governing authority having as-built requirements.
- C. Provide record topographic survey of all stormwater detention and conveyance facilities. Topographic survey shall be utilized to confirm that appropriate detention volume and discharge rates satisfy local municipal regulations.

1.12 EXCAVATION CONDITION

- A. Condition and results of excavation are solely the responsibility of Contractor. Remove slides and cave-ins at whatever time and circumstances such conditions occur. Excavation shall conform to the lines, grades, dimensions and elevations indicated on the Drawings, and shall be in accordance with all applicable OSHA regulations. Contractor shall be responsible for repairing any damage to site structures and features caused during excavation. Contractor shall bear full responsibility for maintaining the stability of excavated faces, including prevention of sloughing of material from excavated faces.

1.13 PROPERTY OF MATERIALS AND EARTHWORK BALANCE

- A. Excess Materials: No right of property is granted Contractor of excavated materials prior to backfilling. This provision does not relieve the Contractor of the responsibility to remove and dispose of surplus excavated materials. Excess material shall be stockpiled at a location on the project site as directed by Owner and stabilized in accordance with Erosion and Sediment Control Plan.
 - 1. Contractor shall stockpile excess topsoil and soil in separate piles.
 - 2. Soil stockpiled shall not include any large boulders or deleterious materials.
 - 3. Boulders and deleterious material shall be segregated and stockpiled separately for disposal by the Contractor.
 - 4. Remove excess soil from the site at completion of earthmoving activities.
- B. Off-site Materials: Any imported soil material required to complete Work shall be furnished by the Contractor in accordance with Section 310050.

1.14 COMPLIANCE WITH AUTHORITIES HAVING JURISDICTION

- A. Local Municipal Improvement Standards and Permits: Contact the local municipality having jurisdiction and obtain any Improvement Specifications, standards, and permits required for construction.
 - 1. Obtain all construction permits that may be required by the municipality having jurisdiction.
 - 2. Perform all Work in municipal roadway and utility rights-of-way or easements in accordance with any applicable municipal standards and regulations. Notify the municipal agency having jurisdiction prior to performing any Work subject to municipal jurisdiction and arranging inspections when required by local municipal representatives. The Owner shall be responsible for all fees incurred as part of the municipal inspections.
- B. Department of Environmental Protection (PADEP): Request copies of all permits issued by the Pennsylvania Department of Environmental Protection from the District for the Work. Comply with the permit and any permit conditions as part of the Work.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Bulk and Backfill Fill Material: As specified in Section 31 00 50.
- B. Imported Fill: As specified in Section 31 00 50.
- C. Engineered Fill: As specified in Section 31 00 50.
- D. Rock Fill: As specified in Section 31 00 50.
- E. Trench Fill Material: As specified in Section 31 00 50.
- F. Clay: As specified in Section 31 00 50.
- G. Topsoil: As specified in Section 31 00 50.

2.2 AGGREGATE BACKFILL

- A. As indicated on the Drawings and as specified in Section 31 00 50.

2.3 GEOSYNTHETIC MATERIALS

- A. Geotextiles: As specified in Section 31 00 50.

2.4 COMPACTION EQUIPMENT

- A. Contractor shall be responsible for providing compaction equipment as required to obtain the densities specified.
- B. The use of puddling or jetting for compacting backfill in trenches is prohibited.

2.5 WATER FOR COMPACTION

- A. The Contractor shall provide water for compaction moisture adjustment. Water available at the job site is metered and Owner is charged for use. Contractor shall only obtain water from within the job site when approved by the Owner.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Identify required lines, levels, contours, datum locations, and benchmarks. Establish horizontal location and vertical grade control.
- B. Stake and flag locations of known utilities. Maintain staking and flagging throughout construction.
- C. Locate, identify, and protect utilities to remain from damage. Protect the existing utilities and structures, both above and below grade, from construction activity and vibration from heavy equipment.
 - 1. Limit and control access across existing and newly installed utilities.
 - 2. Designate selected crossover areas.
 - 3. Utilize hand-operated equipment to compact fill areas over utilities. Compaction equipment should only be operated in the static mode.
- D. Protect plants and other features designated to remain as a portion of final landscaping. Install protective fencing around trees to remain in accordance with the Drawings.
- E. Protect benchmarks, survey control points, fences, sidewalks, paving, curbs, and other improvements from excavation equipment and construction traffic. All benchmark locations disturbed by earthwork operations shall be re-established by a Professional Licensed Surveyor.

3.2 GENERAL PROCEDURES

- A. Erosion and sediment pollution controls shall be installed to intercept runoff prior to initiating earthmoving activities. Erosion and sedimentation controls shall be maintained by the Contractor at all times. Erosion and sediment controls shall be installed in accordance with the Erosion and Sediment Control Plan. A copy of the approved plan shall be maintained on-site at all times.
- B. On-site soils excavated from borrow areas or general excavation shall be stockpiled on-site as directed by District if it cannot be immediately placed. When stockpiling is necessary, stockpiles shall be kept in a neat and well-drained condition and shall be stabilized in accordance with the Erosion and Sediment Control Plan.
- C. Dust shall be controlled by the Contractor using commercially available dust inhibitors or by wetting down dry soil or aggregate surfaces. When using water as a dust control, the Contractor shall be responsible for insuring that excess moisture will not alter or inhibit attaining required compaction densities.
- D. Dewatering:
 - 1. At all times during construction, all Prime Contractors shall provide and maintain pumps to dewater all excavations and prepared subgrades to prevent standing water. Water shall be removed in a manner to minimize the transportation of sediments and in accordance with local Conservation District requirements. Excavations shall be pumped

- dry prior to placement of fill. Remove temporary means of redirecting surface drainage only after the excavation has been backfilled.
2. All water pumped or drained from the Work area shall be directed to an erosion and sediment control trapping device, or to an inlet that is directed to a sediment basin or sediment trap. Pumped water shall not be discharged directly to pavements, newly graded or seeded areas, swales, or off-site areas.
 3. No Contract Price adjustments for removal of unsuitable soils will be paid to the Contractor for failure to maintain dewatering measures at all times during construction.

3.3 FILLING AND BACKFILLING

- A. Prior to filling and backfilling operations, the Contractor shall prepare the subgrade as outlined below.

1. The existing subgrade shall be stripped of all topsoil and pavement materials.
2. Ground surfaces receiving compacted fill for building and pavement support shall be proof rolled and densified with a 20-ton sheepsfoot roller, working in tandem with a 20-ton smooth-drum vibratory roller, until at least 95 percent of the Modified Maximum Density, ASTM D-1557, is obtained. The degree of densification shall be verified by the Contractor by conducting in-place density tests as the proof rolling and densification proceeds.
3. Unsuitable soils (as described in the Geotechnical Report and as identified in the field by the Owner's Geotechnical representative) shall be removed and replaced with suitable material. All unsuitable soils removed by the Contractor may be incorporated into the bulk excavation work in non-structural areas or removed from the site at the Contractor's expense. Written authorization from the Owner is required prior to executing any work in this regard. The Contractor shall be responsible for supplying documentation verifying the amount of unsuitable soils removed and replaced. The Owner will be responsible for tracking the amount of unsuitable soils removed and replacement material used on the project. The Contractor shall only be entitled to compensation for documented quantities of unsuitable soils removed and replaced for the project. Any unused portions shall be credited to the Owner at the end of the project.
4. Soft areas detected during the proof rolling operation should be corrected by either (a) excavating the soft area in those cases where the materials encountered are unsuitable, or too wet to be compacted; or (b) if the moisture content is adequate, densifying the exposed materials.
5. Proof rolling shall extend a minimum of ten (10) feet beyond any structural area of the subgrade.
6. Exposed subgrade surfaces shall be sealed/compacted to create a firm surface prior to completion of earthmoving activities for that day. Sealing/compaction shall be accomplished by overlapping passes of a smooth-drum roller or by similar means to reduce infiltration of surface runoff.
7. After the proof rolling and densification process is completed, the placement of the fill to grade the building pad and pavement areas can occur.

- B. Filling:

1. All fill should be placed in layers ranging from eight (8) to twelve (12) inches in loose thickness and should be compacted to at least 95 to 98 percent of the maximum modified Proctor density, ASTM D-1557, above and below the footing foundation levels.
2. The degree of densification of the fill shall be tested and approved by the Contractor who would conduct in-place density tests in all layers of fill placed.
3. No layer of fill should be added until the previous layer has been tested and approved.
4. While spreading and shaping subgrade layers, all roots, debris, and large stones shall be removed from the fill areas that would otherwise create voids, result in poor compaction, or cause irregularities in the final surface.
5. Placing materials in freezing temperatures or when the ground is frozen is not permitted.
6. Placing materials on areas of ponded water or on excessively wet ground is not permitted.

C. Moisture Control:

1. The moisture content of materials to be placed on site shall be in accordance with the uniform moisture content identified in the Geotechnical Report.
2. When, as determined by the field testing, the fill material is determined to be wet, the Contractor shall aerate the fill material to permit the required compaction density. The drying process must be assisted by disking and/or harrowing.
3. When, as determined by the field testing, that additional moisture is required, water shall be provided by sprinkler tanks, water trucks, or other sprinkling devices in such a way as to provide uniform distribution over the area to be treated with accurate control of the rate and quantity of water applied. If excessive amounts of water are added or if weather conditions cause excessive wetness, the area shall be allowed to dry as described above.
4. When, as determined by the field testing, that the fill material is unsuitable the Contractor shall stockpile it in a separate location for removal from the site.

D. Tests and Field Quality Control: Contractor shall coordinate field testing and inspection with the Districts third party testing agency. The District will pay for all earthwork related testing for the project.

1. Division 1 – General Requirements.
2. Testing: Test reports for field density, optimum moisture content, actual unconfined compressive strength and or bearing tests according to methods referenced.
3. Testing laboratory shall furnish both District and Contractor with required copies of test reports. Same reports will be considered as sufficient evidence of acceptance or rejection of Work.
4. The optimum moisture content and the maximum density of each type of material used for compacted fill shall be determined by ASTM D-1557.
5. The minimum number of tests to be performed in each lift of fill or backfill shall be as scheduled:
 - a. Structural Areas: Five (5) tests for each 5,000 square feet or fraction thereof.
 - b. Non-Structural Areas: Five (5) tests for each 7,500 square feet or fraction thereof.
 - c. Utility Trenches: Two (2) tests for each 50 lineal feet or fraction thereof.

- d. Underground Detention Bed: One (1) test for each 5,000 square feet or fraction thereof.
6. Test locations will be selected on a random basis such that the Contractor will not have any predetermined knowledge of the test locations.
7. When test results indicate that compaction density or moisture content is not as specified, the material shall be recompacted or replaced and recompacted by Contractor to meet specified requirements. All areas requiring recompaction shall be retested to ensure conformance with the specification requirements at no additional cost to the Owner.

3.4 EXCAVATION

A. Excavating Procedures:

1. The Contractor shall be responsible for the preparation and protection of existing structures as part of excavation.
2. Underpin adjacent structures that could be damaged by excavation Work.
3. Prior to excavation, proof roll subgrade for building and pavement areas as outlined in Paragraph 3.3(A). Remove soft spots as described in the referenced Paragraph.
4. Grade top perimeter of excavation to prevent surface water from draining into excavation.
5. Hand trim excavations. Remove loose matter.
6. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard measured by volume.
7. Notify District of unexpected subsurface conditions and discontinue affected Work in area until authorized to continue.
8. Correct areas over excavated in accordance with Filling Procedures.

B. Protection:

1. Prevent displacement or loose soil from falling into excavation.
2. Provide fences around open excavations.
3. Protect bottom of excavations from freezing. All frozen material must be removed from the subgrade prior to placement of fill or aggregate base course.

C. Tests and Field Quality Control: Contractor shall coordinate field testing and inspection with the Districts third party testing agency. The District will pay for all earthwork related testing for the project.

1. Division 1 – General Requirements.
2. Testing: Test reports for field density, optimum moisture content, actual unconfined compressive strength and or bearing tests according to methods referenced.
3. Testing laboratory shall furnish both District and Contractor with required copies of test reports. Same reports will be considered as sufficient evidence of acceptance or rejection of Work.

3.5 TRENCHING

A. General Trench Excavation

1. Begin excavation in trenches at the control point with the lowest invert and proceed upgrade.
2. Remove soil over the line of trenches and separate and store removed materials as suitable for use in backfilling or other purposes.
3. Remove and dispose of unsuitable backfill materials.
4. Contractor shall immediately dewater all open trenches.

B. Trenching:

1. From subgrade elevation to an elevation at least twelve-inches above the top of the outside barrel of the pipe, excavate trench banks to vertical lines and not less than the minimum nor more than the maximum widths indicated in Trench Width Table (A). If sheeting is required, the dimensions in the Table shall apply to the inside face of sheeting.

Trench Width Table (A)

Pipe Diameter	Minimum ¹	Maximum ¹
4" – 24"	12"	16"
27" – 36"	20"	24"
42" – 72"	26"	30"
>72"	30"	36"

¹Trench widths are outside diameter of pipe plus dimension in table. Trenching widths for work within PADOT right-of-way shall meet PADOT RC Standards dated April 4, 2000 as amended.

2. From a point twelve-inches above the top of the outside barrel of the pipe, keep trench banks as nearly vertical as possible for trenches made in paved or unpaved roadways. In no case, shall the trench width at the top exceed the dimensions in Trench Width Table (B). When the excavation limits of Table (B) cannot be held, install temporary shoring, sheeting, and bracing.

Trench Width Table (B)

Pipe Diameter	Maximum ¹
4" – 24"	40"
27" – 36"	42"
42" – 72"	48"
>72"	60"

¹Trench width is to outside diameter of pipe plus dimension in table.

3. When utility trenches are excavated in rights-of-way or easements through open lands, the maximum top of trench width indicated in Trench Width Table (B) may be exceeded

only if the Work can be completed without damaging or utilizing the adjoining property in execution of the Work. The angle of excavation for the trench wall shall be determined by Contractor, but in no case shall the angle of excavation be steeper than one-half foot horizontal to one foot vertical.

4. The dimensions indicated in Trench Width Table (B) may be waived by the District for all trench excavations on Owner's property. The Contractor shall be solely responsible for controlling trench excavation limits and will not be compensated for additional backfilling or excavation as a result of over-excavated trenches or laying back trenches for convenience in not supplying shoring, sheeting, and bracing.
5. All trenching shall conform to OSHA excavation standards, 29 CFR, Part 1926, Subpart B.
6. Length of Open Trench: District shall have the right to limit the amount of trench opened in advance of pipe laying and the amount of pipe laid in advance of backfilling. In no case, shall these lengths exceed 100 feet and 50 feet respectively. Complete trench excavation at least twenty-five feet in advance of pipe laying and keep trenches free of obstructions. At the end of each work day, or discontinuing the Work, the pipe laying may be completed to within five feet of the end of the open trench. Additional open trench limitations are as follows:
7. District may require trench backfilling over completed utility lines or excavations in advance of the lengths to facilitate Owner's use of property or other reasons.
8. If trench excavation is stopped, except as required by District, and the excavation left open, District may require trench to be backfilled at Contractor's expense.

C. Trench Backfilling:

1. Perform trench backfilling in accordance with the details on the Drawings for the appropriate utility.
2. Place backfill on subgrades free of mud, frost, snow or ice.
3. Place and compact soil bedding on trench bottoms. Shape bedding to provide continuous support for bells, joints and barrels of pipes and for joints, fittings and bodies of conduit.
4. Place and compact initial backfill of soil to a height of twelve (12) inches over the utility or conduit. Compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit.
5. Place and compact final backfill of soil to final subgrade elevation.
6. Install warning tape directly above utilities, twelve (12) inches below finished grade.
7. Compaction and Field Quality Control: All trench backfill shall be compacted to 95 percent maximum modified proctor, ASTM D-698 in structural areas and 90 percent maximum modified proctor in non-structural areas. During the course of trench backfilling and compaction, density tests shall be performed by the District's third party inspector to verify Contractor's compaction operations are sufficient to meet specified requirements.

3.6 ROUGH GRADING

- A. The Contractor shall be responsible for establishing subgrades and final grades as shown on the Drawings.

- B. Rough grading shall be performed in conjunction with other clearing, grubbing, filling, and excavating activities. Rough grading shall be performed to permit the site and newly graded to drain freely at all times.
- C. Rough grading shall be done by mechanized equipment, such as a bulldozer, or other means as determined by the Contractor to form the desired line, shape, contour, and grade of the Drawings. Areas adjacent to structures and areas inaccessible to heavy grading equipment shall be graded using smaller excavation equipment, such as a skid loader, or graded by manual methods.
- D. The Contractor shall not allow any heavy excavation equipment on the bottom of the bed. A track hoe must excavate from outside the bed unless low compaction equipment is used and the specific methods have been authorized by the Owner. Any compaction of the bottom of the bed may cause the underground bed to fail to infiltrate.
- E. Slope grades away from building and open excavations at all times. Maintain positive drainage where indicated. Keep areas free of ruts and troughs that will trap and pond surface drainage.
- F. Maintain erosion and sediment controls at all times and conform to approved Erosion and Sediment Control Plan Permit requirements. Install additional controls when directed by the County Conservation District or when deemed necessary by the Contractor due to unanticipated site conditions.
- G. Make all grade changes gradual. Blend slopes into level areas.
- H. Construct surface drainage channels and swales to meet minimum cross-sectional and slope requirements as scheduled on Drawings. Blend channels with adjacent grades. Grade channel invert, excluding "V" shaped channels, to convey flows evenly through channel cross-section. Install velocity checks, stone berms, and other means as necessary to prevent excessive erosion of channel. Provide additional controls beyond those shown on the Erosion and Sediment Control Plan when deemed necessary by the Contractor.
- I. Tolerance: Finished subgrade within one-tenth of a foot (0.10' or 1-1/4") of required design subgrade elevation.

3.7 LANDSCAPE/FINISH GRADING

- A. Substrate Preparation: Eliminate low spots and uneven areas. Remove all stones, roots, brush, wire, stakes, and other debris greater than ½-inch in size. Remove all soil in subgrade contaminated with hydraulic fluids, chemicals, oils, or other material that could inhibit plant growth. When the subgrade soil has developed volunteer weed growth, remove all weeds prior to topsoil using methods that will not affect fertility of the topsoil.
- B. Scarify or till subgrade surface for all areas to receive topsoil.

- C. Placing Topsoil: Topsoil stripped from the site shall be acceptable for placement and finish grading. Topsoil shall be amended in accordance with soil test as part of spreading and tilling in accordance with Section 329200.
- D. General Lawn Areas: Place topsoil to a minimum depth of 4-inches after light rolling.
- E. Place topsoil during dry weather. Do not place or spread frozen or wet topsoil. Permit topsoil to dry when excessively wet prior to spreading and fine grading.
- F. Incorporating Amendments: Amendments shall be incorporated as required by soil test results and as specified in Section 329200 by tilling into topsoil. Amendments shall be thoroughly and uniformly distributed in the upper three-inches of the topsoil.
- G. Fine grade topsoil to eliminate rough or low areas. Maintain profile and contour of subgrade. Place topsoil to within ½-inch of finished surface of sidewalks, slabs, paved areas, and top of curb unless otherwise indicated on Drawings. Remove rocks, weeds, and foreign materials when spreading topsoil.
- H. Remove all stones and debris greater than ½ inch in diameter.
- I. Manually spread topsoil close to plant materials, buildings, site structures, exposed subdrainage systems, areas backfilled with infield mix or other dissimilar materials to prevent damage and mixing of topsoil with other materials.
- J. Lightly compact placed topsoil.
- K. Tolerances: Finished grade of topsoil shall be within ½-inch of finished design grade.
- L. Leave stockpile area clean and raked, ready to receive final landscaping. If excess topsoil was stockpiled at the request of the Owner, grade topsoil pile to form regular, even, side slopes and stabilize as part of final seeding.
- M. Do not permit construction traffic on newly placed topsoil to prevent unnecessary compaction. Use only pneumatic, rubber-tired agricultural style equipment for fine grading and finished spreading of topsoil.

3.8 SUBSURFACE DRAINAGE

- A. Substrate Preparation: Subdrainage Pipe: Specified in Section 334100
- B. Subsurface Stone Trench: Prepare subgrade in accordance with the detail. Place geotextile in accordance with the manufacture's specification. Place a 0 to 6-inch course of stone filter material on the geotextile to support the subdrainage pipe, see specific detail. Encase subdrainage pipe in a minimum of 8 to 12 inches of stone filter material (or as indicated on the Drawings) and wrap in geotextile, overlapping sides and ends at per manufactures specification.

1. Compact each filter material layer to 90- 95 percent of maximum dry unit weight according to ASTM D 1557 in structural areas and 90 percent per ASTM D 698 in non-structural areas.
- C. Subsurface Drain: Place geotextile in accordance with the manufacture's specification, overlapping sides and ends at least 6 inches. Place and compact stone filter material over subsurface drain to provide a minimum of 4 inches over the top of the pipe. Overlay drainage backfill with one layer of subsurface drainage geotextile,
1. Compact each filter material layer to 90- 95 percent of maximum dry unit weight according to ASTM D 1557 in structural areas and 90 percent per ASTM D 698 in non-structural areas.

3.9 SUBBASE AGGREGATE COURSES UNDER SYNTHETIC TURF ATHLETIC FIELDS

- A. All areas of prepared subgrade shall be proof-rolled under the direction of District's third party inspector for approval. Additional compaction testing for the Owner by the third party inspector may be required prior to the Owner and Engineer's approval.
- B. All subgrade must slope a minimum of 0.75% towards and drain directly to the perimeter drain.
- C. Installation of the aggregate base course:
1. Subgrade Shall be inspected by the synthetic surfacing manufacturer for conformity with their standards as well as with planarity requirements as specified prior to placing any geotextile fabric or stone.
 2. Install geotextile fabric and panel drain as indicated on the drawings prior to placement of the stone aggregate.
 3. Shape subbase course to required crown elevations and cross-slope grades.
 4. Place subbase course 6 inches or less in compacted thickness in a single layer.
 5. Place subbase course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 6. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.10 SUBBASE AGGREGATE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course under pavements and walks as follows:
1. Install separation geotextile (where applicable) on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 2. Shape subbase course to required crown elevations and cross-slope grades.
 3. Place subbase course 6 inches or less in compacted thickness in a single layer.

4. Place subbase course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 5. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
- C. Pavement Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.11 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace soil material to depth as directed by District; reshape and re-compact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

END OF SECTION

SECTION 32 12 16 – ASPHALT PAVING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Bituminous paving for site access drives and parking areas.
- B. Bituminous pavement joint sealant.
- C. Pavement repair.

1.2 RELATED SECTIONS

- A. Division 1 – General Requirements
- B. Section 31 00 50 – Basic Site Materials and Methods.
- C. Section 31 10 00 – Site Clearing.
- D. Section 31 20 00 – Earth Moving
- E. Section 33 40 00 – Storm Drainage.

1.3 REFERENCES

- A. Pennsylvania Department of Transportation (PADOT) Specifications Publication, Form 408, as amended.

1.4 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Provide certification for bituminous paving materials as specified in Section 310005.
- C. If recycled materials are used, Contractor must submit a statement from a qualified Geotechnical engineer certifying compliance with the materials specified.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with PADOT Publication 408.
- B. Mixing Plant: Approved by latest PADOT bulletin for bituminous materials.

- C. Obtain materials from same source throughout.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not place asphalt when ambient air temperature or base surface temperature is less than 40 degrees or surface is wet or frozen.
- B. Place bituminous mixture when temperature is not more than 15 degrees below bitumen supplier's bill of lading and not more than the maximum specified temperature.

1.7 COORDINATION

- A. Coordinate work in accordance with Division 1- General Requirements and so as to avoid conflicts with other operations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stone Base Course:
 - 1. As specified in Section 31 20 00
- B. Bituminous Materials
 - 1. Asphaltic cement: As specified in Section 31 00 05.
 - 2. Base Course: As specified in Section 31 00 05.
 - 3. Wearing Course: As specified in Section 31 00 05.
 - 4. Bituminous tack coat: As specified in Section 31 00 05.
- C. Bituminous Pavement Joint Sealant.
 - 1. Curb joints: Emulsified asphalt, AC-20, conforming to PADOT Publication 408, 461.2. Do not seal curb joints prior to painting curb, where indicated.
 - 2. Pavement cracks/joints greater than ¼ inch: Single component, hot-pour petroleum based pavement crack and joint sealant meeting ASTM D 3405, ASTM D1190, AASHTO M173, and AASHTO M301, Roadsaver 221, as manufactured by Crafcro, Inc. (1-800-528-8242) or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.

- B. Verify gradients and elevations of subgrade are correct.

3.2 STONE BASE COURSE

- A. In accordance with Section 31 20 00 and Section 31 00 05.

3.3 PREPARATION - TACK COAT

- A. Apply tack coat over existing surface in accordance with PADOT Publication 408, 460.3.
- B. All areas to be cold-milled shall comply with PA DOT Publication 40.

3.4 PLACING PAVEMENT

- A. Place bituminous binder course and/or wearing course in accordance with PADOT Publication 408, 401.
- B. Place pavement to the compacted thickness indicated.
- C. Seal all joints at all curbs and storm water structures where the final wearing course will not be installed for more than 45 days.
- D. Neatly sawcut at all edges between new pavement and existing pavement to remain.
- E. Protect adjacent surfaces from pavement applications. Restore surfaces to previous condition as required.

3.5 BITUMINOUS PAVEMENT REPAIR

- A. Seal all isolated joints with pavement joint and crack sealant as specified. Sawcut and remove pavement and subbase at areas of reflective cracking caused by construction traffic or deficient Work that will not support required final loading. Recompact the subgrade to the specified density. Proofroll subgrade and remove any soft spots in accordance with Section 02300. Place and compact subbase aggregate and bituminous pavement materials as specified. Reflective cracking may be addressed prior to the placement of overlay paving with fiberized asphalt membrane in accordance with PADOT Publication 408, Sections 468 and 469 when approved by the Architect after review with the geotechnical consultant.

3.6 FIELD QUALITY CONTROL

- A. Division 1 – General Requirements
- B. Pavement Coring: For each pavement section specified at each area on the Drawings, provide one (1) core sample to verify pavement thickness, but no less than one (1) core sample per 5,000

square feet of paved area. Backfill, compact and seal test holes with the specified material after the measurements have been performed. Pavement more than ¼ inch deficient in depth and cannot be satisfactorily corrected will be considered defective. When defective pavement is encountered, additional core holes will be required, at no additional compensation, to determine the extent of the deficient area. All defective pavement shall be replaced to conform to the required cross-section.

3.7 TOLERANCES

- A. Flatness: Maximum variation of ¼ inch measured with a 10-foot straight edge in any direction. Finished bituminous surface shall be smooth in appearance and free from ruts and/or washboard.
- B. Scheduled compacted thickness: Within ¼ inch.
- C. Variation from finished grade: Within ½ inch.

3.8 SCHEDULE

- A. All pavement cross-sections and limits of paving are scheduled on the Drawings.

END OF SECTION

SECTION 32 13 13 – CONCRETE PAVING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Plain cement concrete curbs.
- B. Plain cement for concrete sidewalks, slabs, stairs and ramps.
- C. Concrete Footings for site furnishings and site lighting.

1.2 RELATED SECTIONS

- A. Division 1 – General Requirements
- B. Division 3 – Concrete
- C. Section 31 00 50 – Basic Site Materials and Methods.
- D. Section 31 10 00 – Site Clearing.
- E. Section 31 20 00 – Earth Moving
- F. Section 33 40 00 – Storm Drainage.

1.3 REFERENCES

- A. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
- B. ASTM CC979 – Pigments for Integrally Colored Concrete.
- C. Pennsylvania Department of Transportation (PennDOT) Specifications Publication 408, as amended, Sections 630 and 633.
- D. ACI 305R - Hot Weather Concrete Placement.
- E. ACI 306R – Cold Weather Concrete Placement.
- F. Pennsylvania Department of Transportation (PennDOT) Standards for Roadway Construction, Publication 72, as amended, RC-64 and 67.

1.4 SUBMITTALS FOR REVIEW

- A. Submittal procedure as specified in Division 1. All exterior concrete shall be obtained from the same plant to ensure uniformity of the mix.
- B. Contractor shall review placement of scoring joints and expansion with District prior to starting flat work.
- C. Contractor shall submit sample of detectable warning pavers to be used on the projects, District to select from standard range of available colors.
- D. Test Reports: Submit laboratory test reports for concrete materials and mix design.

1.5 PROJECT CONDITIONS

- A. Environmental Conditions:
 - 1. Conform to ACI 305R when placing concrete during hot weather.
 - 2. Conform to ACI 306R when placing concrete during cold weather.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with the Quality Assurance requirements of Division 3.
- B. Perform concrete paving and curbing in accordance with PennDOT Specifications and Roadway Construction Standards except as modified by this Section and Division 3 Specifications.

1.7 COORDINATION

- A. Coordinate Work in accordance with Division 1- General Requirements
- B. Coordination of the concrete pours with items to be imbedded in the concrete.

PART 2 - PRODUCTS

2.1 BASIC MATERIALS

- A. Form Materials:
 - 1. Concrete Curbs: Extruded; form radii or areas inaccessible to curb machine using flexible spring-steel forms or laminated boards to form radius bends.
- B. Joint Filler and Sealant: Material as specified in Section 310050. Provide joint filler and sealant as scheduled:

Item/Location	Joint Filler	Joint Sealant
Pedestrian walks, slabs, stairs and ramps	ASTM D1752	ASTM C920 tinted to match concrete
Loading Slabs and Equipment Slabs	ASTM D1751	Not required for self-sealing fiber
Curb	ASTM D 1751	ASTM D 1850
Curb – Adjacent to concrete walks and courtyards	ASTM D1752	ASTM C920 tinted to match concrete

C. Reinforcing Steel and Wire Fabric: As specified on the Drawings.

D. Concrete Materials:

1. As specified in the classifications for site concrete as scheduled in Section 310050.

2.2 ACCESSORIES

A. Concrete Curing Compounds and Sealers

1. Plain Cement Concrete Curing and Sealing Compound: Water-emulsion acrylic concrete sealer meeting ASTM C309, Type 1, Class B, AASHTO M148, Type 1, Class B, equal to Sealtight, CS-309 Clear Acrylic Concrete Curing and Sealing Compound, distributed by W.R. Meadows, Inc. (1-800-342-5976).
2. Colored Concrete Curing and Sealing Compound: Not Used.
3. Exposed Aggregate and Cementitious Exposed Aggregate Curing and Sealing Compound: Not Used.

B. Grout: Non-shrink, non-staining, metallic grout as specified in Section 03300.

C. Detectable Warning Surface: The Contractor shall provide detectable warning surface pavers at all locations indicated on the plans and/or where flush curbing or handicap ramps are located. This surface treatment shall comply with ADA and PA DOT requirements and must be approved by the District prior to installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify base conditions in accordance with Section 312000.
- B. Verify compacted subgrade and granular base is acceptable and ready to support paving and imposed loads.

- C. Verify gradients and elevations of base are correct.

3.2 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Notify District minimum 24 hours prior to commencement of concrete operations.

3.3 FORMING

- A. Perform all forming Work for rigid concrete pavements in accordance with the Drawings.
- B. Perform all forming Work for concrete curbing in accordance with PennDOT Publication 408, Section 630.3 or place curb using a self-propelled curb machine.

3.4 REINFORCEMENT

- A. Place reinforcement for site lighting footings as scheduled on drawings.
- B. Place reinforcement in pavement and curbs where scheduled and in accordance with PennDOT Publication Standards for Roadway Construction, RC-64.

3.5 PLACING CONCRETE

- A. Place concrete for curbs using self-propelled curb machine or form and pour in accordance with PennDOT Publication 408, Section 630.3(c).

3.6 CURING CONCRETE

- A. Cure all exterior concrete using curing and sealing compounds as specified. Perform Work in accordance with manufacturer's specifications.

3.7 JOINTS

- A. Place expansion joints as scheduled on Drawings. Recess joint filler for sealant placement for sealed expansion joints. Where jointing pattern is not indicated, place expansion joints at equal increments not exceeding twenty-four feet. Place joints to form regular repetitive pattern of even increments. Align curb, gutter, and sidewalk joints.
- B. At the end of the curing period, clean and fill expansion joints with joint sealer. Fill joints flush with the concrete surface.
- C. Place isolation joints at points of contact between slab and vertical surfaces.
- D. Provide control joints at patterns and intervals indicated or as approved by the District to form

a regular repetitive pattern of equal increments.

- E. Form control joints at optimum time during concrete placement. Finish joint edges with ¼-inch radius. Control joints shall be a minimum of 1/4 of the slab or sidewalk depth. Sawcut control joints in concrete curbing in accordance with PennDOT Publication 72, RC-64.
- F. Curb Expansion Joints: Place expansion joints for concrete curb in accordance with PennDOT Publication 408, Section 630.3(e), and Publication 72, RC-64. Seal joints as scheduled.

3.8 FINISHING

- A. Equipment Pads: Float finish.
- B. Sidewalks and slabs: As scheduled on Drawings.
- C. Concrete Curbing: As specified in PennDOT Publication 408, Section 630.3(c).

3.8 SEALING AND CURING COMPOUND

- A. Apply concrete sealer to all new concrete curbs, sidewalks and slabs in accordance with the Manufacturer's specifications.

3.9 TOLERANCES

- A. Section 01450 - Quality Control: Tolerances.
- B. Maximum Variation of Surface Flatness: ¼ inch in 10 feet.
- C. Maximum Variation From True Position: ¼ inch.
- D. Curbs: Not to deviate more than ¼-inch in 10-feet in grade and alignment.

3.10 FIELD QUALITY CONTROL

- A. Section 01450 - Quality Control: Field inspection.
- B. Field Quality Control for testing and inspection of exterior concrete pavement shall be in accordance with Section 03300. Replace concrete not meeting specified requirements.

3.11 PROTECTION

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- B. Do not permit pedestrian or vehicular traffic over pavement until 75 percent design strength of

concrete has been achieved.

- C. Repair damaged concrete and clean concrete discolored during construction. Replace concrete that cannot be cleaned. Remove concrete that is damaged and reconstruct to entire length between scheduled joints. Refinishing damaged concrete is not acceptable.

END OF SECTION

SECTION 32 17 23 – PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Liquid traffic paint materials.

1.2 RELATED SECTIONS

- A. Section 32 12 16 – Asphalt Paving: for pavement materials and installation.
- B. Section 32 13 13 – Concrete Paving: for pavement materials and installation.

1.3 REFERENCES

- A. Commonwealth of Pennsylvania, Department of Transportation, Publication 408/2000 – Specifications, as amended.
 - 1. Section 901, Maintenance and Protection of Traffic During Construction.
 - 2. Section 962, Painting Traffic Lines and Markings.
 - 3. Section 963, Pavement Marking Removal.
 - 4. Section 1103, Traffic Signing and Marking.
- B. Commonwealth of Pennsylvania, Department of Transportation, Publication 35, Approved Construction Materials (Bulletin 15), as amended.
- C. Commonwealth of Pennsylvania, Department of Transportation, Publication 68, Regulations – Traffic Signs, Signals and Markings, as amended.
- D. Commonwealth of Pennsylvania Code, Title 67, Department of Transportation, Chapter 203, Work Zone Traffic Control.
- E. American Society for Testing and Materials:
 - 1. ASTM D711-89(1998) Standard Test Method for No-Pick-Up Time of Traffic Paint.
 - 2. ASTM D868-85(1998) Standard Test Method for Evaluating Degree of Bleeding of Traffic Paint.
 - 3. ASTM D969-85(1998) Standard Test Method for Laboratory Determination of Degree of Bleeding of Traffic Paint
 - 4. ASTM D1309-93(1998) Standard Test Method for Settling Properties of Traffic Paints During Storage.
- F. Federal Standard 595B – Colors, 1989, as amended.

- G. Institute of Transportation Engineers, Equipment and Material Standards of the Institute of Transportation Engineers, “A Model Performance Specification for the Purchase of Pavement Marking Paints and Powders”, 2001, as amended.
- H. Environmental Protection Agency, Code of Federal Regulations 40, Section 261.24.

1.4 SUBMITTALS

- A. Submittal Procedure as outlined in Division 1 – General Requirements
- B. Product Data
 - 1. Liquid traffic paint.
- C. Certificates
 - 1. Manufacturer’s pavement marking material certification that the material meets or exceeds:
 - a. PennDOT Publication 408, Section 1103 – Traffic Signing and Marking.
 - b. Institute of Transportation Engineers, Equipment and Material Standards of the Institute of Transportation Engineers, “A Model Performance Specification for the Purchase of pavement marking Paints and Powders”.
- D. Manufacturer’s Instructions
 - 1. Application method, mixing instructions and surface preparation for:
 - a. Liquid Traffic Paint.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver pavement marking materials to job site in their original, sealed containers or packages with intact and legible labels at time of use.
 - 1. Store paint containers lid-down.
 - 2. If the paint is used within two months after being received, no rotation prior to use is required. If the paint is on hand for more than two months, rotate paint several days before use.
- B. Store approved materials at the job site in a suitable and designated area restricted to storage of pavement marking materials and related equipment.
- C. Ensure safe storage of pavement marking materials and the prompt and safe disposal of waste. Store all products protected from weather when such products may be affected by freezing or high temperatures.

1.6 PROJECT CONDITIONS

A. Environmental Requirements:

1. Adhere to manufacturer's data on air and surface temperature limits and relative humidity during application and curing of pavement markings.
2. Schedule work to avoid dust and airborne contaminants.

B. Protection:

1. Protect pavement marking materials before, during, and after application.
2. Remove pavement marking material from curbs, sidewalks, or other improvements due to overspray, spills, or other reasons.

1.7 WARRANTY

- A. For a period of one year from the Date of Substantial Completion, replace any pavement marker, portion of the pavement marker, or legend material that has proven defective.
- B. For a period of 180 days from the Date of Substantial Completion, replace all defective liquid traffic paint markings demonstrating a loss of reflectivity, wear, or poor adhesion resulting from defective materials or workmanship.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Liquid traffic paint markings: Ready-mixed pigmented binder in a single package system suitable for application to traffic bearing surfaces such as Portland cement concrete, asphalt concrete pavements and plain or vitrified brick surfaces of streets, highways, bridges, tunnels, and parking lots.
 1. Waterborne or alkyd formulations sourced from an approved manufacturer listed in PennDOT Bulletin 15 (Pub 35)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Maintenance and protection of traffic: PA Code Title 67, Chapter 203 – Work Zone Traffic Control.
- B. Removal of pavement markings: PennDOT Publication 408, Section 963.

- C. Allow new asphalt or concrete to cure 7 days prior to marking, or until the moisture content is below 4%. Mechanically remove laitance and curing compounds prior to applying the pavement markings.
- D. Surfaces: Dry and blown or swept clean just before application.
- E. Surface temperature range for application: 40-100 F.

3.2 APPLICATION

- A. Application of pavement markings:
 - 1. PennDOT Publication 408, Section 963.
 - 2. PennDOT Publication 68.
- B. See plan and details for proposed pavement markings. Allow asphalt to cure for a minimum of 7 days before applying pavement markings.
- C. Repair any marking deemed to be defective by the engineer for not being in accordance with the plans and details prior to project final acceptance.

3.3 PROTECTION PAVEMENT MARKINGS

- A. Provide protection of markings from vehicular traffic in accordance with manufacturers recommendations.
- B. Traffic is to be kept off all pavement markings until it has dried sufficiently to prevent dirt pick-up or tracking.

END OF SECTION

SECTION 32 18 13 – SYNTHETIC TURF ATHLETIC FIELD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Free draining base material
2. Free draining infilled synthetic turf system.
3. Inspection and certification of the turf base system.
4. Resilient base pad requirements
5. Turf Maintenance Equipment

1.2 SUBMITTALS

A. Manufacturer's Qualifications:

1. Reference list of at least ten (10) fields supplied by the Infilled Synthetic Turf Vendor of the type and installation process specified herein with contact name, address and telephone number to enable such data to be validated prior to the commencement of work.
2. Reference list of at least five (5) fields installed by the Infilled Synthetic Turf Installer of the type and installation process specified herein with contact name, address and telephone number to enable such data to be validated prior to the commencement of work.
3. Job Resumes of Infilled Synthetic Turf System Installer's Installation Supervisor showing supervision of five (5) field installations and Infilled Synthetic Turf System Installers. Include reference contact names, addresses and telephone numbers to enable such data to be validated prior to the commencement of work.
4. Cut Sheets for all materials required under this Section including third party ASTM certified lab reports.
5. Material Safety Data Sheets (MSDS) for all materials required under this Section.
6. Manufacturer's written warranties for all individual components of the Infilled Synthetic Turf System.
7. Provide a sample written 8-year labor and materials Insured Warranty from the Infilled Synthetic Turf Vendor.
8. A signed letter on company letterhead holding the Owner, Landscape Architect and all other project consultants harmless for any violation of patent rights or infringement.

B. Shop Drawings:

1. The Infilled Synthetic Turf Vendor shall coordinate and provide details that illustrate the scope of work, including but not limited to materials, cross sections, subsurface and penetration details.
2. The Turf Vendor shall provide an underlayment (where applicable) and seaming plan at 1" = 20'-0". The seaming plan shall include all tufted lines.
3. The Turf Vendor shall provide a striping plan at 1" = 20'-0" which demonstrates compliance with applicable PIAA/NFHS requirements for the layouts shown on the Drawings and in these Specifications. The striping plan shall indicate all tufted and inlayed field markings.

C. Product Samples and Information:

1. Provide color samples of dual fiber polyethylene fiber for approval.
2. Provide a minimum 12-inch by 12-inch sample of dual fiber polyethylene carpet.
3. Provide a 12" x 12" sample of Underlayment.
4. Provide sieve analysis of infill materials for approval.
5. Provide a 1-quart sample of the infill mix.
6. Provide turf warranty language.
7. Provide underlayment cut sheet.
8. Provide underlayment warranty language.
9. Provide a sample written 8-year labor and materials Warranty from the Infilled Synthetic Turf Vendor.
10. Provide a signed letter on company letterhead holding the Owner, Landscape Architect and all other project consultants harmless for any violation of patent rights or infringement.

D. Delivery slips for all Free Draining finishing stone.

E. Delivery slips for all Infilled Synthetic Turf System materials delivered to the site.

F. As-Built Field Layout Drawing prior to infilling with certification that the field layouts meet the requirements of PIAA/NFHS and the project documents.

G. Maintenance Manual to the Owner.

H. G-Max testing results identifying compliance with specifications after completion. Testing shall be in accordance with ASTM Standards and include a gridded analysis of infill depths.

1. G-Max testing shall be in accordance with technical requirements of ASTM 355-23 and F1936-19. (ASTM Standards are available from www.astm.org).
2. Provide a report identifying the following information:
 - a. Identification of material tested, including type, source, manufacturer's lot number (if appropriate), thickness (if measurable, and any other pertinent information.
 - b. Conditions of test, including temperature, humidity, and any other pertinent data.
 - c. Date of test.
 - d. Procedure used and missile description.
 - e. Impact Velocity.
 - f. Average values of last two of three impacts or as specified.
 - g. G-Max Value
 - h. Head Injury Criterion (HIC) Value
3. A spreadsheet with the above date and infill levels for each test location.
4. A field diagram identifying test locations / results / infill levels.
5. Raw data from device that generates velocity, G-Max and HIC

1.3 QUALITY ASSURANCE

- A. Field Survey: Site Contractor shall provide a survey and verify the accuracy of the turf base surface precision tolerances of the athletic field. Survey of athletic field subgrade shall be in digital format on 10 ft. grid, including 0.10' contours. Survey shall be submitted to the Landscape Architect. Any unacceptable surface deviations or conditions shall be reported in writing to the Landscape Architect. Installation of synthetic turf underlayment and/or turf system shall not commence until irregularities of the subgrade have been corrected to the Landscape Architect's satisfaction.
- B. Pre-installation Conference: A pre-installation meeting shall be scheduled, in writing, between the Site Contractor, Subcontractors, Landscape Architect to review the scope of work in this Section, coordination with other work, special project conditions and quality standards. It shall be the Site Contractor's responsibility to notify and schedule the pre-installation a minimum of two (2) weeks prior to the anticipated start of the work specified under this Section.
 - 1. Verify scope of work responsibility of each contractor and subcontractor.
 - 2. Review proposed sources of all synthetic turf field materials, including capabilities and location of plant that will manufacture materials.
 - 3. Synthetic turf manufacturer to certify that the product to be installed, including pigmented field lines, does not contain lead.
 - 4. Review condition of substrate.
 - 5. Review requirements for protecting all stages of work, including restriction of traffic during installation period and for remainder of construction period.
 - 6. Review and finalize construction schedule for all work. Verify availability of materials, installer's personnel and equipment required to execute the Work without delays.
 - 7. Review inspection and testing requirements, governing regulations and proposed installation procedures.
 - 8. Review forecasted weather conditions and procedures for coping with unfavorable conditions.

1.4 WARRANTY

- A. Warranty: The Infilled Synthetic Turf Vendor shall guarantee all self-manufactured and / or procured Infilled Synthetic Turf Systems, materials and workmanship against damage by normal climatic conditions or proper and normal use for a minimum period of eight (8) years from the official date of Substantial Completion. In addition, the Infilled Synthetic Turf Vendor shall guarantee all self-manufactured and procured materials and / or workmanship including such defects as premature decrease in infill height, premature decrease in pile height or weight (stipulated as more than 10% decrease), UV degradation, fading, seam rupture, dislodgement, inadequate drainage or inadequate air transmission. The guarantee shall be in writing and shall be signed by the Infilled Synthetic Turf Vendor stating that any defects, including the need to remove and replace self-manufactured and / or procured materials will be repaired at no cost to the Owner within 90 days written notice of the Owner. The warranty shall not have a deductible and / or be prorated and cover full replacement value of field square footage.

PART 2 - PRODUCTS

2.1 GENERAL

- A. This specification covers the installation of new outdoor multi-purpose Infilled Synthetic Turf System comprised of tufted synthetic turf with mixture of sand and SBR rubber filled into the pile. Where indicated, the system may also include resilient underlayment for added player safety. The installed system shall have a permeability rate in excess of ten (10) inches per hour. The tufted synthetic turf is comprised of parallel slit film and monofilament polyethylene pile sewn into a urethane backed carpet meeting F.D. Doc FF1-70 and ASTM D-2859 flammability requirements, with an abrasion index of less than 25 per ASTM F1015 and meeting the following values for Static Coefficient of Friction per ASTM F1551.

1. Dry Surface Static Friction 1.06 minimum
2. Dry Surface Sliding Friction 0.96 minimum
3. Wet Surface Static Friction 1.00 minimum
4. Wet Surface Sliding Friction 0.83 minimum

2.2 FREE DRAINING INFILLED SYNTHETIC TURF BASE MATERIALS

- A. Geotextile Fabric shall be a needle-punched nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. Fabric shall be inert to biological degradation and resistant to naturally encountered chemicals, alkalis, and acids.

1. Geotextile Fabric - Shall be equivalent to Mirafi 140N as manufactured by Ten Cate and shall meet the following requirements:

Mechanical Properties	ASTM Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	D4632	lbs (N)	120 (534)	120 (534)
Grab Tensile Elongation	D4632	%	50	50
Trapezoid Tear Strength	D4533	lbs (N)	50 (223)	50 (223)
CBR Puncture Strength	D6241	lbs (N)	310 (1380)	
Apparent Opening Size	D4751	US Sieve (mm)	70 (0.212)	
Permittivity	D4491	Sec ⁻¹	1.7	
Flow Rate	D4491	Gal/min/ft ² (l/min/m ²)	135 (5500)	
UV Resistance (at 500 hours)	D4355	% strength retained	70	

¹ ASTM D 4751: AOS is a Maximum Opening diameter value.

B. Free Draining Crushed Stone:

1. Shall be a 3/8" double washed durable crushed rock consisting of the angular fragments obtained by breaking and crushing solid or shattered natural rock, and free from a detrimental quantity of thin, flat, elongated or other objectionable pieces. A detrimental

quantity will be considered as any amount in excess of 15% of the total weight. Thin or elongated pieces are defined as stones whose average width exceeds four (4) times their average thickness. Elongated stones shall be considered to be stones whose average length exceeds four (4) times their average width. The Free Draining Crushed Stone shall be uniformly blended according to the gradation requirements for the respective stone sizes for the following:

<u>Sieve Designation</u>	<u>% Passing by Weight</u>	
	Minimum	Maximum
1/2 in.	100	--
3/8 in.	85	100
No. 4	20	50
No. 8	0	15
No. 16	0	5

2. Free Draining Crushed Stone shall bridge with selected Free Draining Finishing Stone material to prevent loss of Free Draining Finishing Stone material into Free Draining Crushed Stone layer.
3. Free Draining Crushed Stone Base to be fine graded to a tolerance of 1/4" in 25' with hydraulically controlled laser grading apparatus.
4. Free Draining Crushed Stone Base shall drain at a rate of not less than twenty (20") inches per hour after compaction.
5. Based upon the type and source of Free Draining Crushed Stone Base and Free Draining Finishing Stone submitted, other criteria may be required for approval.

C. Free Draining Finishing Stone:

1. Shall be inert angular crushed rock derived from a stone quarry that is hard, durable and free of deleterious materials and shall not consist of natural or crushed sand. Materials that break up when alternately frozen and thawed or wetted and dried shall not be used. The Free Draining Finishing Layer shall be uniformly blended according to the gradation requirements for the respective stone sizes for the following (1/2" maximum particle size):

<u>Sieve Designation</u>	<u>% Passing by Weight</u>	
	Minimum	Maximum
1/2 in.	100	--
3/8 in.	85	100
No. 4	60	90
No. 8	35	75
No. 16	10	55
No. 30	0	40
No. 60	0	15

No. 100	0	8
No. 200	0	2

2. Free Draining Finishing Stone shall bridge with selected Free Draining Crushed Stone drainage material to prevent loss of Free Draining Finishing Stone into Free Draining Crushed Stone layer.
3. Installed Free Draining Finishing Stone to be fine graded to a tolerance of 1/8" in 10' with hydraulically controlled laser grading apparatus.
4. Installed Free Draining Finishing Stone shall drain at a rate of no less than ten (10) inches per hour after compaction.
5. Based upon the type and source of Free Draining Finishing Stone submitted, other criteria may be required for approval.

2.3 RESILIENT UNDERLAYMENT

A. Resilient Underlayment, Rubber Pad:

1. Underlayment pad shall be porous and made specifically as a resilient base for outdoor athletic fields with a minimum thickness of 12 mm. Pad shall have an infiltration rate of not less than 12 inches per hour, a minimum recovery rate of 94% at 100 psi per ASTM F36, tensile strength > 50 psi per ASTM D412, G-Max < 110 per ASTM F355A, vertical deformation < 10mm, resistance to bacteria and fungi.

2.4 INFILLED SYNTHETIC TURF SYSTEM

A. Tufted Synthetic Turf, General performance requirements subject to manufacturers specifications.

1. Yarn shall be a UV resistant parallel slit film and monofilament blended polyethylene pile designed for high use multi-purpose outdoor infilled synthetic athletic turf applications. Yarn shall generally meet the following requirements:

Field Color: Combination of Olive, Field or Verde Green similar to natural grass as selected by owner from the Manufacturer's Standard Colors.

Line & Layout Tick Colors: selected by owner from the Mfg's Standard Colors

Pile Denier: 10000 denier minimum per ASTM D 1907

Pile Height / Weight: 2.25" / 50-56 oz.

(per sq. yd.) per ASTM D 5848

Stitch Count: 11 stitches per inch per ASTM D 5848

Stitch Gauge: 3/8" - 1/2" gauge per ASTM D 5848

Thickness: min. 100 microns (slit film), min. 300 microns (monofilament) per ASTM D 3218

Break Load: 30 psi minimum per ASTM D 2256

Elongation at Break: 10% minimum per ASTM D 2256

Tuft Bind: 7 lbs./ft minimum without fill per ASTM D 1335

- B. Primary Carpet Backing, General requirements subject to manufacturers specifications.:
 - 1. Shall be equivalent to Multilayer Thiobac PRO C18 as manufactured TenCate Grass North America, Dayton, TN.
 - 2. If necessary, additional fabric layers or other provisions shall be made to accept butt-sewn seams. Additional layers or provisions shall not compromise the integrity of the system.
- C. Secondary Coating General requirements subject to manufacturers specifications.
 - 1. Shall be high quality polyurethane specifically formulated for outdoor synthetic turf carpet. The Secondary Coating shall be heat treated to hold the yarn in place and shall meet the following requirements:
 - 2. Weight 20 oz. per s.y. minimum
- D. Rolls shall be a minimum of 15 feet wide. Rolls shall be of sufficient length to cover from sideline to sideline without head seams.
- E. The Site Contractor shall provide sewn seams. The sewn portion of seams shall be performed with high strength chord suitable for attaching outdoor Infilled Synthetic Turf carpet. The Infilled Synthetic Turf System Contractor is informed that all seams shall be flat and indiscernible upon installation. Shearing of the pile will not be permitted as a means of achieving a flat seam.
- F.
- G. Adhesives for bonding tufted synthetic turf shall be one-part moisture cured polyurethane obtained from a single manufacturer and be equivalent Nordot 34-G as manufactured by Synthetic Surfaces, Scotch Plains, NJ (908) 233-6803 or approved equal. Adhesive shall be modified with amendments as recommended by the manufacturer for installation during adverse weather conditions.
- I. If the Infilled Synthetic Site Contractor intends to modify any of the above criteria, it shall first be approved in writing by the Landscape Architect prior to submitting a bid.

2.5 INFILL MATERIALS

- A. Infill Materials shall be uniformly filled to a depth which leaves no more than 1/2" of exposed pile after settlement, and consist of a homogeneous non-compacting mixture of silica sand and recycled rubber granules meeting the following criteria:
 - 1. 50 / 50 sand / rubber ratio mixed by weight.
 - 2. Infill ratio may be altered by turf manufacturer to provide specific performance characteristics by approval of Landscape Architect / Owner.

- B. Silica sand shall meet the following criteria:
 - 1. Infill sand shall be high quality clean grains of rounded silica sand.
 - 2. Angular or sub-angular particles will not be accepted.
- C. SBR rubber shall meet the following criteria:
 - 1. SBR Rubber: Granules shall be processed recycled rubber derived from passenger tires. Rubber shall contain no dust or contaminants and shall work to hold the infill sand in suspension. Color to be black.
 - 2. Recycled infill is not permitted.
- D. Samples of the free draining, homogenously blended infill (and separate sand and rubber) shall be submitted to the Landscape Architect for review.

2.6 FIELD LAYOUT

- A. Field layouts shall be in accordance with NFHS Standards for all sports identified to be inlaid.

PART 3 - EXECUTION

3.1 SUBGRADE

- A. Refer to Section 312000 " Earth Moving" for grading requirements and Grade Control System for establishing subgrade.
- B. All areas of prepared subgrade must slope a minimum of 0.75% towards and drain directly to the perimeter drain.
- C. Surface Inspection: Prior to installation of the aggregate base course:
 - 1. Shall be proof-rolled under the direction of the Owner's Representative Engineer and geotechnical engineer for approval. Additional compaction testing for the Owner by the Engineer and geotechnical engineer may be required prior to the Owner and Engineer's approval.
 - 2. Shall be inspected by the synthetic surfacing manufacturer for conformity with their standards as well as with planarity requirements as specified.

3.2 WEATHER CONDITIONS

- A. Construction of the aggregate base course and synthetic surface shall not be performed at any time when inclement weather threatens, rain is imminent or falling or when conditions are, in the opinion of the Construction Manager or Landscape Architect, unsuitable.
- B. If exposed subgrade is subject to precipitation, it shall be properly drained and dried and must meet all grading and compaction requirements, be acceptable to the Construction manager and Landscape Architect prior to installation of the aggregate base.

3.3 GEOTEXTILE FABRIC

- A. Geotextile fabric shall be placed as recommended by the manufacturer and approved by the Construction Manager or Landscape Architect on the precision graded subgrade as shown on the plans. Seams shall be overlapped a minimum of 12 inches.

3.4 PREFABRICATED FLAT PANEL DRAIN SYSTEM

- A. Install 1" x 12" prefabricated under-drain system according to the manufacturer's written instructions in herringbone design as shown on drawings.
- B. The contractor shall supply all necessary connectors, fasteners and miscellaneous materials and is responsible for proper and secure connections.
- C. Tape the under drains every 15' to the fabric using suitable duct tape.

3.5 STONE BASE COURSE

- A. Place base course material over geotextile fabric and field subdrain system. Use caution to prevent damage or rupture to the fabric or drain pipes.
 - 1. Compact base course to required grades, lines, cross sections and thickness of not less than ninety five percent (95%) of ASTM D 4254 relative density.
 - 2. Shape base to required crown elevations and cross-slope grades.
 - 3. When thickness of compacted base course is six inches (6") or less, place materials in a single layer.
 - 4. When thickness of compacted base course exceeds six inches (6"), place materials in equal layers with no layer more than six inches (6") thick or less than three inches (3") thick when compacted.
 - 5. The compacted base course layer shall be inspected by the Site Contractor by means of a laser level on a 25-foot grid pattern. An electronic survey of the surface shall be generated and submitted to the Construction Manager and Landscape Architect for review and approval. Based on the inspection of the topological survey, the Site Contractor shall fine grade the compacted base course layer suitably - including proper rolling and compaction - to achieve a tolerance of 1/4" in 25'.
 - 6. The Site Contractor shall verify that the Free Draining Crushed Stone layer and Subsurface Drainage System are functioning properly prior to installing the Free Draining Finishing Stone layer.
 - 7. Install and rough grade the Free Draining Finishing Stone layer in accordance with Specifications to the depths as shown in the Project Details.
 - 8. The Free Draining Finishing Stone layer shall be inspected by the Site Contractor by means of a laser level on a 10-foot grid pattern and the Site Contractor. An electronic survey of the surface shall be generated and submitted to the Construction Manager and Landscape Architect for review and approval. Based on the inspection of the topological survey, the Site Contractor shall rough grade the Free Draining Finishing Stone layer suitably - including proper rolling and compaction - to achieve a maximum tolerance of 1/8" in 10'.

9. If the base materials fail to drain at the specified rates, they shall be repaired or removed and replaced at no cost to the Owner until they achieve the specified requirements.
10. Final grade of stone base shall replicate grades as shown on drawings. Center crown of field shall not be a hard angle, but parabolic in nature. Crown shall not be a visual intersection of field sides and shall be flattened if a hard angle is observed.

3.6 STONE FINISHING COURSE

- A. Add finishing stone material over existing stone base as needed to provide smooth base surface. Modify edge transitions to accommodate resilient base pad installation for smooth transition to concrete curb glue shelf. Install geogrid where shown for base stabilization and support. Compact edges to eliminate settlement. Fine grade entire field to match predevelopment slopes and tolerances. Notify Landscape Architect / owner of any inconsistencies identified throughout the grading processes.
- B. Subsequent to completion of the finishing course, the Site Contractor shall verify that the Base Stone is functioning properly. Verification shall be via third party Dual Ring Infiltrometer Testing (ASTM D3385-9) (or other pre-approved method) coordinated and paid for by the Site Contractor. Five (5) tests shall be performed in locations determined by the Construction Manager and/or Landscape Architect. Each test location shall have a permeability rate in excess of ten (10) inches per hour. If preliminary results in the field do not yield ten (10) inches per hour, the Construction Manager and/or Landscape Architect may ask for additional locations to be tested. Site Contractor shall provide written verification to Landscape Architect and/or Owner.

3.7 RESILIENT UNDERLAYMENT

- A. Stone base shall be reviewed and approved by contractor, owner, and owner's representative prior to the installation of underlayment. Contractor to continuously review and ensure subbase to be uniform, flat and not contain any foreign objects during installation. Do not drive or walk across stone subbase to avoid deformation. Install rolls / panels in accordance with manufactures specifications. Butt-joints shall be a maximum of 5mm unless otherwise noted in the manufacturer specifications and taped together.

3.8 SYNTHETIC TURF SURFACE

- A. The synthetic Site Contractor shall strictly adhere to the installation's procedures specified herein. Any variance from these requirements shall be accepted in writing by the manufacturer, and submitted to the Landscape Architect, verifying that the changes do not in any way affect the warranty.
- B. The installation shall be performed in full compliance with approved design drawings, and only by factory-trained technicians, skilled in the installation of sewn athletic caliber artificial grass systems, working under the direct supervision of a principal of the company.
- C. The surface to receive the synthetic turf shall be inspected and certified as ready for the installation of the synthetic turf system by the manufacturer or by a supervisor with a minimum five years' experience in the installation of such fields. The surface must be

perfectly clean as installation begins and shall be maintained in that condition throughout the process.

- D. The Site Contractor shall adjust and grade out subbase during Turf installation as required to meet existing elevations and slopes. No dips or undulations will be permitted.
- E. To aid in the proper installation of the synthetic turf, the Contractor shall water the aggregate base as required by the synthetic turf installer in order to achieve proper compaction during synthetic turf installation.
- F. The Resilient Underlayment shall be installed in full rolls with the longest feasible length or uniform panels. Resilient Underlayment rolls that require trimming to meet the side and end curb shall be a minimum width of three (3) feet and a minimum length of ten (10) feet. Upon completion of Resilient Underlayment installation, the Resilient Underlayment shall be inspected for planarity and grade and all deviations shall be corrected by tamping with a hand operated vibratory plate compactor.
- G. Tufted Synthetic Turf Rolls shall be installed perpendicularly across the field. Turf rolls shall be of sufficient length to permit full cross-field (football sideline – football sideline) installation. No head or cross seams will be allowed. Once all playing football surface rolls have been installed, install sideline rolls perpendicularly to playing surface rolls and attach directly to the concrete glue shelf. Rolls shall be installed so that tufted lines are placed as shown on the approved Shop Drawings. All rolls shall be installed with nap in like direction.
- H. Tufted Synthetic Turf shall be installed with no wrinkles, ripples or bubbles. Shearing of fibers, slits in the fabric or driven spikes or staples to relieve such defects will not be permitted.
- I. All Tufted Synthetic Turf seams shall be sewn with high strength chord as stated above. Seams shall be flat, tight, and permanent with no separation or fraying. Tufted Synthetic Turf Yarn pile that is trapped between seams shall be freed from the seams by hand or other approved method to an upright position prior to brushing and infilling. Extreme care shall be taken to prevent carpet pile from becoming trapped underneath the infill. If necessary, the Landscape Architect / owner may direct the Infilled Synthetic Turf Installer to completely remove and reinstall the infill.
- J. All Tufted Synthetic Turf inlays and other field markings shall be cut and adhered with high strength tape and glued as stated above. Inlay seams shall be flat, tight, and permanent with no separation or fraying. Tufted Synthetic Turf Yarn pile that is trapped or glued between inlay seams shall be freed from the seams by hand or other approved method to an upright position prior to brushing and infilling.
- K. Tufted Synthetic Turf panels used for access to subsurface utilities shall be adhered with hook and loop Velcro attachment system glued to turf backing.
- L. Turf panels that are cut in error shall be replaced in their entirety. Patching of errant cuts is not permitted.
- M. Upon completion of seaming and inlaying and prior to infilling, the entire field shall be brushed with a motorized rotary nylon broom to free trapped or tangled fibers. The blended

infill materials shall be spread evenly by using a drop spreader in multiple applications at uniform rates until the specified infill depth (after settlement) is achieved. Between applications the infill materials shall be brushed in multiple directions with a static nylon groomer.

3.9 LOGOS AND GRAPHICS

- A. Electronic files for all logos and graphics will be provided to the Turf Vendor by the Landscape Architect / owner. Do not scan images from Project Documents or Approved Shop Drawings or download images from websites for use in fabricating logos or graphics.
- B. Logos and graphics as indicated on the Drawings shall be inlaid per the Approved Shop Drawing. The logos and lettering formats have been provided as details in the plan set.

3.10 ACCEPTANCE

- A. Any imperfections that develop in the substrate or surface prior to the final acceptance shall be removed and replaced with new materials.
- B. All such repair work shall be done at no additional cost to the Owner.

3.11 CLEAN UP

- A. Turf Vendor shall provide the labor, supplies and equipment as necessary for final cleaning of surfaces and installed items.
- B. All useful and usable remnants of new materials shall become the property of the Owner. A minimum of 1500 square feet of tufted synthetic turf in field green shall be provided including at least four (4) 15' x 20' sections. A minimum of fifteen (15') linear feet of each color shall be provided in the appropriate game line width.
- C. Surfaces, recesses, enclosures, etc. shall be cleaned as necessary to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the Owner.

3.12 CLOSE OUT

- A. Turf Vendor shall provide the Landscape Architect with three (3) copies of the approved Warranty prior to final payment.
- B. Turf Vendor shall train the Owner's designated personnel in the proper maintenance and care of the field and provide the Landscape Architect with three (3) copies of the Standard Maintenance Manual.
- C. Turf Vendor shall provide the Owner with a minimum of 1500 square feet of tufted synthetic turf in field green. Turf shall be provided in a minimum of four (4) 15' x 20' sections. A minimum of fifteen (15') linear feet of each line color shall be provided in the appropriate game line width.

- D. Turf Vendor shall provide the Owner with one (1) ton (supersack) of rubber infill. Locate adjacent to field at the owner's direction.

3.13 ADDITIONAL EQUIPMENT

- A. Turf Grooming Equipment: The turf vendor shall provide turf grooming equipment (brush) as recommended to maintain turf systems. For a minimum standard of quality: GreensGroomer, Model # 920 SDE as manufactured by GreensGroomer Worldwide, Inc. or approved equivalent.
- B.

3.14 MAINTENANCE AND WARRANTY

- A. Synthetic turf shall be warranted against defects in materials and workmanship for period of eight (8) years from date of substantial completion.
- B. The manufacturer's warranty shall include general wear and damage caused by UV degradation. Vandalism and damage from natural cause beyond the control of the Owner or the manufacturer are excluded from the warranty.
- C. The manufacturer's warranty shall provide a warranty to the Owner covering defective installation and warrants that the installation was performed in accordance with the manufacturer's recommendations and directions.
- D. The warranty shall guarantee the G-max rating of 115 at time of installation and below 165 for the remaining term of the warranty.
- E. The turf manufacturer, as part of the warranty, shall have an independent testing agency perform a G-max test of the surface at the beginning and end of the first full season. If the G-max exceeds acceptable limits listed here, the turf manufacturer, as a part of the warranty, shall take corrective measures as approved by the Owner and the Landscape Architect.

END OF SECTION

SECTION 32 31 13 – CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Chain link fence framework, fabric, and accessories for chain link fences and gates.

1.2 RELATED SECTIONS

- A. Section 310050 – Basic Site Materials and Methods
- B. Section 312000 – Earth Moving
- C. Division 3 - Concrete

1.3 REFERENCES

- A. Chain Link Fences, Gates and Backstops:
 - 1. ASTM A121 - Zinc-Coated (Galvanized) Steel Barbed Wire.
 - 2. ASTM A123 - Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
 - 3. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 4. ASTM A392 - Zinc-Coated Steel Chain-Link Fence Fabric.
 - 5. ASTM A428 - Test Method for Weight of Coating on Aluminum-Coated Iron or Steel Articles.
 - 6. ASTM A491 - Aluminum-Coated Steel Chain Link Fence Fabric.
 - 7. ASTM A569 - Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial Quality.
 - 8. ASTM A585 - Aluminum Coated Steel Barbed Wire.
 - 9. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 10. ASTM A792 - Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
 - 11. ASTM A824 - Metallic Coated Steel Marcellled Tension Wire for Use with Chain Link Fence.

12. ASTM B429 - Aluminum-Alloy Extruded Structural Pipe and Tube.
13. ASTM C94 - Ready-mixed Concrete.
14. ASTM F567 - Practice for Installation of Chain-Link Fence.
15. ASTM F900 - Industrial and Commercial Swing Gates.
16. ASTM F1043 - Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
17. ASTM F1083 - Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
18. CLFMI (Chain Link Fence Manufacturers Institute) - Product Manual.
19. ASTM F668 – Poly (Vinyl Chloride) (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
20. ASTM F934 – Colors for Polymer-Coated Chain-Link Fence Materials.
21. ASTM F1664 – Poly (Vinyl Chloride) (PVC) – Coated Steel Tension Wire Used with Chain-Link Fence.

1.4 SUBMITTALS

- A. Submittal procedure as specified in Division 1.
- B. Shop Drawings: Indicate plan layout, spacing of components, post footing dimensions, hardware, anchorage, and schedule of components.
- C. Product Data: Manufacturer's catalog cuts indicating material compliance and specified options.
- D. Manufacturer's Installation Instructions: Submit installation requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines.
- B. Operation and Maintenance Data: Procedures for submittals.

1.6 QUALITY ASSURANCE

- A. Supply chain link fence material in accordance with CLFMI - Product Manual and

manufacturer having minimum five years experience in fabrication of chain link fence materials.

- B. Qualifications: Company specializing in erection and assembly of specified components with minimum three years experience and with service facilities within 150 miles of project site.
- C. Substitutions: Other Manufacturers are permitted to submit as long as their product meets the criteria established in PART 2. It shall be the Contractor's burden to provide information under 1.4.

1.7 MATERIAL WARRANTY

- A. Provide only products for metal fencing with a manufacturer's standard warranty of 15-years for fence materials indicating that system is free from defects in material and workmanship including cracking, peeling, blistering, and corroding from the date of purchase.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Fence fabric and accessories shall be delivered to the construction site in packed cartons. Painted or coated components shall be protected to avoid scratching or damaging exposed finished surfaces. Fence fabric shall be package or delivered in firmly tied rolls.
- B. Each package shall be identified and shall bear the manufacturer's name.
- C. Store fence materials and accessories in a secure and dry place.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Chain Link Fences and Gates Manufacturers:

- 1. Anchor Fence Inc.
- 2. Cyclone Inc.
- 3. Master Halco, Inc.
- 4. Hoover Fence Company.

2.2 MATERIALS AND COMPONENTS

- A. Chain Link Fence:

- 1. Materials and Components: Conform to CLFMI Product Manual.

2. Line Posts: Type I, round pipe per ASTM F 1043, diameter in accordance with fence height.
 3. Corner and Terminal Posts: Type I, round pipe per ASTM F 1043, diameter in accordance with fence height.
 4. Top Rail and Brace Rail: 1.66 inch diameter per ASTM F 1043, plain end, sleeve coupled.
 5. Bottom Rail: 1.66 inch diameter per ASTM F 1043, plain end, sleeve coupled.
 6. Chain Link Fence Fabric: Standard Industrial 2-inch diamond mesh interwoven steel wire, 9 gauge thick as indicated on the plans, top salvage knuckle end closed, bottom salvage knuckle end closed. All chain link fabric shall be polymer coated meeting ASTM F668 and components meeting ASTM F934 and ASTM F1664; color: black.
 7. Tension Bar: 3/16 x 3/4 inch thick steel in one piece lengths equal to 2-inches less than full height of fabric or equivalent fiberglass rod.
 8. Tension Clip: As required to attached tension bar to terminal posts.
 9. Tie Wire: Aluminum alloy steel wire.
 10. Caps: Cast steel galvanized; sized to post diameter, set screw retainer, flat top.
 11. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; galvanized steel.
 12. Polymer Coating: All posts, rails, braces, caps, wires, fabric and fasteners shall be polymer coated (where possible) meeting ASTM F668 and components meeting ASTM F934 and ASTM F1664; color: black.
 13. Hardware Finish: Polymer-Coated.
 14. Accessories Finish: Polymer-Coated.
 15. Concrete: Class A Concrete as specified in Section 310050.
- B. Chain Link Fence Gates:
1. General: Gate types, opening widths and directions of operation shall be as shown on the Drawings. Gates shall be designed for operation by one person.
 2. Swing Gates: Swing gates shall be factory assembled, and shall swing 180 degrees.
 3. Gates shall conform to ASTM F900 except that framing shall be assembled by welding at

the corners. Use of corner fittings shall not be permitted.

4. Gate Posts: Type I, round pipe, 2.5-inch OD for 6 foot leaf or less, Type I, round pipe, 3-inch OD for 6 feet to 12 feet gate leaf.
 5. Gate Hardware: Mechanical keepers; two, 180 degree non-lift off gate hinges per leaf for gates 6 feet high and less, three, 180 degree non-lift off gate hinges per leaf for gates 12 feet high to 6 feet high, forked type latch and hardware for padlock.
 6. Gate Frame: 1.66 inch diameter for welded fabrication. For gates over 8-feet high, provide additional horizontal and vertical interior members to ensure proper strength.
 7. Fabric: Match fence fabric material and finish for chain link fencing.
 8. Caps: Cast steel galvanized, sized to post diameter, set screw retainer, flat top.
 9. Fittings and Accessories: Galvanized steel, finish to match fence component fittings and accessories.
 10. Concrete: Class A Concrete as specified in Section 310050.
- C. Cantilever Slide Gates: Provide two (2) cantilever slide gates per the dimensions indicated on the Drawings. The gate shall be provided in accordance with the manufacturer's size specifications and shall generally be consistent with Item 2.2 Material and Components so that all components match. Specifically, all posts, rails, braces, caps, wires, fabric and fasteners shall be polymer coated (where possible) meeting ASTM F668 and components meeting ASTM F934 and ASTM F1664; color: black.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify areas ready to receive fencing are competed to final grades and elevations, are seeded and stabilized, or fence installation will not interfere with final seeding or damage newly seeded areas.
- B. Verify that property lines, fence alignment, and legal boundaries of work are clearly identified.

3.2 INSTALLATION

A. Chain Link Fencing and Gates:

1. Install framework, fabric, accessories and gates in accordance with ASTM F567.

2. Place fabric on outside (security side) of posts and rails for perimeter fencing. Install fabric on inside (playing field) side for baseball field fencing
3. Set intermediate, terminal, gate, and backstop posts plumb, in concrete footings with top of footing 6 inches below finish grade. Drive anchor posts may be used for line posts in place of concrete footings. Slope top of concrete for water runoff.
4. Line Post Footing Depth Below Finish Grade: ASTM F567.
5. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567.
6. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.
7. Provide top rail through line post tops and splice with 6-inch long rail sleeves. Provide hardware and bottom rail for baseball field fencing.
8. Install center and bottom brace rail on corner gate leaves.
9. Do not stretch fabric until concrete footing has sufficient strength. Contractor shall be responsible for determining when sufficient strength has been attained.
10. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
11. Position bottom of fabric 2 inches above finished grade for perimeter fencing. Position bottom of fabric at finish grade for baseball field fencing.
12. Fasten fabric to top rail, bottom rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.
13. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
14. Install bottom tension wires stretched taut between terminal posts for perimeter fencing. Install bottom rail for baseball field fencing.
15. Do not attach the hinged side of gate from building wall; provide gate posts.
16. Install gate with fabric to match fence. Install required hinges per leaf, latch, catches, and locking clasp.
17. Install fence with all posts vertical and all components to the line and grade shown on the Drawings.
18. The clear opening from end posts to buildings, fences and other structures shall not exceed 6 in unless otherwise approved in advance by the Architect.

19. Excavate holes for posts to the diameter and spacing as required without disturbing the underlying materials.
20. Center and align posts. Place concrete around posts, and vibrate or tamp for consolidation. Recheck vertical and top alignment of posts and make necessary corrections. Unless otherwise approved by the Architect, no materials shall be installed on the posts, nor shall the posts be disturbed within 7 days after the individual post footing is completed.
21. Install cantilever slide gates in accordance with manufacturer instructions and approved shop drawings. Install in accordance with CLFMI.

3.3 ERECTION TOLERANCES

- A. Section 01400 - Quality Requirements: Tolerances.
- B. Maximum Variation From Plumb: 1/4 inch.
- C. Maximum Offset From True Position: 1 inch.
- D. Components shall not infringe adjacent property lines.

3.4 CLEANING AND TOUCH-UP

- A. Clean up debris and unused material, and remove from the site.
- B. Clean or wash all screen system fencing to remove dirt, grease, or other materials from fence, gates, and components.
- C. Touch up components scratched or otherwise marred with paint supplied by manufacturer. Architect reserves the right to reject any fencing that the factory finish has been marred, materials dented, or otherwise damaged by the supplier or Contractor during erection, storage, or delivery.

END OF SECTION

SECTION 32 33 00 – SITE FURNISHINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Roadway and parking area appurtenances.
- B. Traffic Signs and Site Information Signage.
- C. Site Amenities

1.2 RELATED SECTIONS

- A. Division 1 – General Requirements
- B. Section 310050 – Basic Site Materials and Methods
- C. Section 312000 – Earth Moving
- D. Section 323113 – Chain Link Fences and Gates
- E. Division 3 –Concrete: Concrete materials and construction for footings, sleeves, and related Work of this Section.

1.3 REFERENCES

- A. Pennsylvania Department of Transportation (PennDOT) – Specifications Publication 408, Latest Edition, PennDOT Publication 236, Hand Book of Approved Signs, and Standard Traffic Control, TC-7700 Series.

1.4 SUBMITTALS

- A. Product Data: Submit product data, manufacturers installation instructions and specifications, standard color samples, catalog cuts or manufacturer’s standard shop drawings as required by Division 1- General Requirements.
- B. Approved Sign Source: Traffic Control Signage – Submit manufacturer’s Pennsylvania Department of Transportation certification for material and fabrication of traffic control signage or certification that materials and construction meets PennDOT Publication 408, Section 1103 and PennDOT TC 7800 Series.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Operation and Maintenance Data – Submit manuals and instructions for continued Owner maintenance.
- B. Additional Parts – Submit spare parts, touch-up paint, and other excess materials.
- C. Manufacturer’s Warranties – Provide manufacturers warranties for specified equipment, where applicable.

1.6 COORDINATION

- A. Coordinate Work in accordance with Division 1 – General Regulations.
- B. Coordinate with Work of other trades. Schedule equipment installation to avoid interference with progress of other Work or that will result in damage to site equipment and furnishings.

PART 2 - PRODUCTS

2.1 ROADWAY AND PARKING APPURTANCES

- A. Recycled Plastic Wheel Stops: Not Used.
- B. Precast Concrete Wheel Stops: Minimum 6-feet X 7-1/2-inches X 5-inches, reinforced with two No. 4 steel bars, minimum concrete strength of 3,500 psi.
- C. Steel Guiderail: Not Used.
- D. Wood Guiderail: Not Used.
- E. Steel Bollards: Dimensions as scheduled on Drawings, schedule 40 steel pipe, 6-inch diameter, concrete filled; prime and paint with two coats of reflective safety yellow paint to exposed portion of bollard.
- F. Removable Bollards: Dimensions and materials as specified on the Drawings.
- G. Loading Area Guardrail: Not Used

2.2 TRAFFIC SIGNS AND SITE INFORMATION SIGNAGE

- A. On-Site Traffic Control Signs: Provide traffic control signs as scheduled on Drawings.
 - 1. Sign Posts: Breakaway carbon steel square as indicated on Drawings, materials and workmanship meeting PennDOT Publication 408, Section 1103.08, finish in accordance with Method 1 with the exception that the paint color shall be semi-gloss black.

2. Sign Blanks: Flat sheet aluminum 6061-T6, of size scheduled, meeting the requirements of PennDOT Publication 408, Section 1103.04.
 3. Letters, Numerals, Accessories, Borders, and Symbols: Sheeting material per PennDOT Publication 408, Section 1103.02(d). Spacing in accordance with TC-7700 C, as applicable, and PennDOT Publication 236, HandBook of Approved Signs, Regulatory Series (R-Series).
- B. Public Roadway Traffic Control Signs: Provide traffic control signs for public roadways as scheduled on the Drawings.
- C. Site Information Signage: Provide site information signage as indicated on Architectural Drawings.
1. Shop Drawing Submittal: Contractor shall provide shop drawing for review before installation. Contractor shall make provisions for electrical supply as indicated on the Drawings.

2.3 ACCESSORIES

- A. Concrete Footings: Class A as specified in Section 310050. Depth of footing to be a minimum of 36 inches below finished grade. No footings are to be exposed to the finished grade.
- B. Soil and Aggregate Backfill: Backfill materials shall be as specified in Section 310050.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that areas of installation are prepared and ready to receive Work of this Section.
- B. Verify that all components are provided and that equipment is not damaged prior to installation.
- C. Verify dimensions of all equipment and accessory components to ensure proper installation. Notify Architect if specified equipment does not meet field measured dimensions or design intent.

3.2 INSTALLATION

- A. General: Install and assemble all site improvements and amenities in accordance with manufacturer's installation instructions and specifications. Where differences exist between installation as noted on Drawings and requirements of the manufacturer, or installation cannot be executed in strict accordance with manufacturer's specifications, notify Architect.

- B. Traffic Control Signage: Install traffic control signage where located and as indicated on Drawings. Post installation, assembly of post and sign blanks, mounting heights, sleeves, and other installation requirements for traffic signage shall be in accordance with PennDOT TC-7700 Traffic Control Series Drawings and as shown on the Drawings.
- C. Site Informational Signage: Site Informational Signage: Install site informational signage where indicated on Drawings.
- D. Wheel Stops: Locate wheel stops as scheduled on Drawings.
 - 1. Secure to bituminous pavement using minimum ½-inch diameter steel reinforcement bar anchor pins.
 - 2. Do not use wheel stops that are chipped, spalled, or cracked. Remove defective or damaged wheel stops from site.
 - 3. Align wheel stops and install parallel to edge of pavement.

3.3 PROTECTION

- A. Protect all site equipment stored on site to prevent damage prior to installation. Prior to installation of any equipment, inspect to verify that the equipment has not been damaged during delivery or storage.
- B. Protect all equipment following installation to prevent damage to apparatus or displacement in footing prior to concrete attaining required strength to resist movement. Protect until Owner acceptance.

3.4 CLEANUP

- A. Following installation, and prior to requesting inspection for Owner acceptance, clean all site improvements and amenities to remove grease, oils, stains, dirt, and other blemish. Clean only with materials and products recommended by manufacturer.
- B. Touch-up any scratches or nicks on painted and coated surfaces with matching color and material of painted or coated surface. Architect reserves the right to reject any apparatus or equipment that is damaged or has required repainting or recoating of more than five-percent of the factory applied painted or coated surface.

END OF SECTION

SECTION 32 50 00 – MISCELLANEOUS SITE IMPROVEMENTS

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the furnishing and installation of certain items of outdoor equipment and other miscellaneous site improvements. In certain instances, quantity may be specified herein. Section includes, but is not limited to, the following:
 - 1. Bleacher System (Portable)
 - 2. Athletic Field Construction
 - 3. Ball Control Netting
 - 5. Miscellaneous
- B. Appurtenances: Equipment shall be furnished and installed, complete with fittings, hardware, and footings necessary for erection and installation, and accessories and other appurtenances necessary for use and operation. Concrete footings and other anchorage shall be provided as required by manufactures specifications.

1.2 SUBMITTALS

- A. Product Data: Manufacturer's technical and descriptive literature for each item specified.
- B. Shop Drawings: Submit shop drawings which fully and comprehensively detail all items of equipment, with erection and installation requirements, for the Landscape Architect's review and acceptance prior to delivery of any such equipment. Show recommended concrete footing locations, depth and size.
- C. Samples:
 - 1. Show selected finishes for equipment and furnishings.

PART 2 - PRODUCTS

2.1 BLEACHER SYSTYEMS

- A. Portable Bleacher Unit: Furnish and install per manufacturer's instructions +/- 500 seat bleacher unit with ADA accessibility on one end and stairs on both ends. 36-inch elevated, 10 row with surrounding chain link protection fencing as furnished by National Recreation Systems (NRS) (888-568-9064) or equal to identify a standard of quality. One portable bleacher unit is required for each proposed turf field, including the Alternate Bid.

2.2 ATHLETIC FIELD CONSTRUCTION

- A. Geo-Composite Underdrain (Flat Drain)

1. Provide a 1" x 12" underdrain system fabricated from high-density polyethylene pipes and surrounded by a synthetic geotextile.
2. Performance Criteria:
 - A. Core:
 - i. Thickness: 1.0 in., ASTM D-1777
 - ii. Flow Rate: 30 gpm per ft., ASTM D-4716
 - iii. Pipe Stiffness: 100 psi, ASTM D-2412
 - iv. Compressive Strength: 6000 psf, ASTM D-1621, Sand Method
 - B. Geotextile:
 - i. Weight: 4.0 oz. per sq. yd.², ASTM D-3776
 - ii. Tensile Strength: 100 lbs., ASTM D-4632
 - iii. Coefficient of Perm: 0.2 cm. per sec., ASTM D-4491
 - iv. Flow Rate: 140 gpm per ft.², ASTM D-4491
 - v. Apparent Opening Size: 70 maximum US standard sieve opening, ASTM D-4751.
 - vi. UV Stability: 70% strength retained at 500 hours, ASTM D-4355
 - vii. Seam Strength: 150 lbs. per ft., ASTM D-4595
 - viii. Fungus: No Growth, ASTM G-21
3. Acceptable Products/Manufacturers:
 - A. Multi-Flow
 - B. SportsEdge HQ
4. Fittings and Pipe:
 - A. Fittings used with the drain shall be as recommended by manufacturer for drainage product.
 - B. The 1" x 12" flat drains shall connect to perimeter tile drain with pre-manufactured or approved fittings. Provide all necessary connectors and waterproof tape for a proper and secure connection to the collectors.
 - C. Attach flat drains to fabric every 15 feet with suitable duct tape on nails as required to prevent movement of drains during installation of stone aggregate base course.
- B. Combox Electrical / Communications Boxes: Furnish and install per manufacturer's instructions the following items of equipment as furnished by Sportsfield Specialties, Delhi, NY 13753, (888) 975-3343 to identify a standard of quality:
 1. Combox with Patented Infill Retainer System, (1) Model # CBIT1850 (3500.5)
- C. Utility Boxes: Furnish and install per manufacturer's instructions the following items of equipment.

1. Quazite Underground Enclosure Assembly. Polymer concrete construction with open bottom. 6 ¾" height, 9" wide x 11" long. Solid cover. Set top flush with finish grade.

2.3 BALL CONTROL NETTING (Multi-Purpose Fields)

- A. Netting (Ball Stop): Install sleeve and foundation and sleeve per manufacturer's instructions and as shown on plans, the following items of equipment as furnished by Sports Edge, Troutman, NC 28166, (800) 334-6057 to identify a standard of quality:
 1. SEBNS30P – 30' Ball Stop (straight), Foundation size increased to 60" depth, Poles are 6" diameter 6061-T6 aluminum with wall thickness of 0.25", Poles are located 20' o.c. maximum or as spaced on the Drawings. Netting is 1 ¾" square, knotless with break strength of 180lbf high tenacity polypropylene, extra UV stabilizers for extended life. Tie netting to existing netting at juncture allowing no more than 1 ¾" opening. Includes rope Pulley System, all hardware to be stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION – GENERAL

- A. Install miscellaneous site improvements in accordance with manufacturer's instructions, the requirements specified under Parts 1 and 2 of this Section, and in conformance with the Drawings and Shop Drawings.

END OF SECTION

SECTION 32 92 00 – TURF AND GRASSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Amending Topsoil.
- B. Seeding and Mulching.
- C. Sodding.
- D. Maintenance.

1.2 RELATED SECTIONS

- A. Division 1- General Requirements
- B. Section 31 00 50 – Basic Site Materials and Methods
- C. Section 31 10 00 – Site Clearing
- D. Section 31 20 00 – Earth Moving

1.3 RELATED DOCUMENTS

- A. Erosion and Sediment Control Narrative and Erosion and Sediment Control Plan: Requirements for temporary seeding, permanent stabilization, site stabilization during construction as approved by the County Conservation as it relates to the requirements of the PADEP Chapter 102 Regulations.

1.4 DEFINITIONS

- A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.
- B. Erosion and Sediment Control Plan: Includes all plans, narratives, calculations, and conditions of the E&S Permit, as applicable, as approved and issued by the County Conservation District and Pennsylvania Department of Environmental Protection. A copy of the approved plans and permit must be available on-site at all times during construction.

1.5 STANDARDS

- A. All seed varieties contained in the seed mixtures shall be certified seed by the state where the seed was manufactured.
- B. All chemical applications shall be performed in accordance with local, state, and federal regulations utilizing EPA registered materials and methods of application. All chemical applications shall be performed under the supervision of a Licensed Certified Applicator.

1.6 SUBMITTALS

- A. Manufacturer's Certified Analysis: Submit manufacturer's certified analysis for each seed mix showing percentage of each variety in mix, percent pure live seed, net weight by variety in mix, age of seed, and date of production.
- B. Soil Test Report: Submit copy of soil test reports as prepared by State Cooperative Extension or approved laboratory determining existing soil parameters as included in Paragraph 2.1.B. Test reports shall be submitted for information only and for evaluating soil amendments recommended by Contractor.
- C. Soil Amendments and Turf Establishment Program: Based on soil test reports, prepare and submit a schedule of soil amendments and fertilization required for each seed mix, time and method of application, a schedule indicating when areas will be seeded, anticipated dates of Substantial Completion, fertilization practices during establishment, application of pre-emergent and post emergent herbicides, and other practices that will be employed as part of the Work. The submittal will be considered by the District for informational purposes only since the Work of this Section is evaluated by the final establishment of the lawn at the end of the warranty period.
- D. Product Data: Submit product data, manufacturer's installation instructions, specifications, catalog cuts, and manufacturer's standard shop drawings as required by Section 01330.

1.7 SUBSTITUTIONS

- A. The Contractor shall make every reasonable effort to find the seed varieties and materials specified. The District shall approve requests for substitutions. Contractor shall submit request in writing, state the reasons for the substitution, and state the variety or mix to be substituted.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in seeding, turf establishment, and maintenance with five years documented experience.

1.9 COORDINATION

- A. The Contractor shall coordinate and schedule Work to permit seeding to occur during regular planting seasons.

1. General lawn areas shall be seeding during the spring or fall planting seasons.
- B. Coordinate Work under provisions of Division 1 – General Requirements and so as to avoid conflict with other operations. Contractor shall be responsible for reseeding any areas damaged due to a failure to coordinate or schedule construction activities.
- C. Notify District a minimum of three days in advance of all maintenance work including fertilizing, reseeding, over-seeding, and application of herbicides following initial seeding through substantial completion.

1.10 PLANTING SEASONS

- A. Spring: The spring seeding season is April 1 to May 30. Spring seeding shall be conducted during this period unless approved by the District to begin seeding earlier or perform summer seeding. No seeding shall be done on frozen ground, when the air temperature is less than 32-degrees Fahrenheit, or when the soil temperature is less than 50-degrees Fahrenheit regardless of the date of seeding. Contractor must obtain permission from the District to seed outside of the above timeframes.
- B. Fall: The fall seeding season is September 1 to October 30. Fall seeding shall be conducted during this period unless approved by the District to perform seeding earlier or to perform late fall seeding. No seeding shall be done on frozen ground, when the air temperature is less than 32-degrees Fahrenheit, or when the soil temperature is less than 50-degrees Fahrenheit regardless of the date of seeding. Contractor must obtain permission from the District to seed outside of the above timeframes.
- C. Optimal: The optimal seeding season is in the fall, from September 15 to October 15. More rapid germination will occur for most seed varieties when the soil temperature is between sixty- and seventy-degrees Fahrenheit.

1.11 INSPECTION AND ACCEPTANCE

- A. Inspection: Upon completion of the Work as defined in Paragraph 1.13.A, or completion of contiguous areas equal to at least twenty-five percent of the total area seeding, request an inspection to determine substantial completion. Request shall be made to the District in writing and District shall complete inspection within two weeks of receipt of request for inspection. Contractor shall clearly note in request for inspection which areas are substantially complete if not requesting inspection for the entire installation.
 1. District shall issue a notice of Substantial Completion following inspection where Work is substantially in conformance with the specified requirements and Drawings. Minor deficiencies shall be noted and Contractor shall correct all deficiencies within two-weeks of receiving notice.
 2. Where District determines that Work is not substantially complete due to significant deficiencies, Contractor shall take immediate corrective action. Upon completion of corrective measures, Contractor shall again request inspection to determine if Substantial Completion has been obtained.

- B. Perform all maintenance activities required as part of Substantial Completion described in Paragraph 1.13.B prior to requesting inspection.

1.12 WARRANTY

- A. Approval of the District to perform seeding Work outside of the regular planting seasons when requested by the Contractor shall not void the warranty in any way. Requests by the District to perform seeding outside of the regular seeding seasons shall alleviate the Contractor from providing warranty for failure of germination due to unsuitable soil temperature conditions, frost kill, or dormancy due drought conditions.
- B. Contractor shall for a period of one year from the Date of Substantial Completion, rebuild, repair, or replace any areas of lawn that have proven defective due to failure to comply with the Specifications in any way. Contractor is not responsible for unsatisfactory areas of lawn due to vandalism, areas that have been damaged by the District or District's use, or as a result of the District's failure to execute maintenance procedures following completion of the Contractor's maintenance period.

1.13 MAINTENANCE SERVICE

- A. Maintain seeded areas immediately after placement until grass is well established. Contractor shall be responsible for maintenance of all seeded areas until a vigorous, weed free, healthy growing condition is present and Substantial Completion is established. A request for inspection for Substantial Completion will not be considered by the District until a vigorous uniform growth over at least 90% of the seeded area is present.
- B. When seeding is requested by the Contractor outside of the scheduled planting seasons, the Contractor shall perform all additional maintenance, provide additional mulch, frost protection blanket, compost, increased seeding rate, over-seeding, and other Work as required to improve germination conditions at no additional cost to the District.
- C. Seeding requested by the District outside of the scheduled planting seasons or beyond the limits of the Contract Documents is considered Additional Work and must be approved by a written Change Order prior to execution.

PART 2 - PRODUCTS

2.1 TOPSOIL

- A. On-site available topsoil or approved imported topsoil as specified in Section 310050. The Contractor shall be responsible for providing satisfactory topsoil as required to meet the quantities necessary for the Work.
- B. Soil Testing: Soil tests shall be done prior seeding. The soil test shall include a mechanical analysis to determine soil texture, pH, magnesium, phosphorus, and potassium. Testing shall also measure organic matter and soluble salts. The minimum number of soil tests shall be as

specified in Section 31 00 50. Topsoil shall not be tested until it has been stripped and stockpiled. All imported topsoil shall be approved by the District before the material is delivered to the site.

- C. Soil Amendments: Contractor shall amend topsoil as determined by the soil tests to adjust soil conditions as require for each variety and species of grass. Soil adjustments shall be made based upon the dominant variety in the seed mix. Where soil tests indicate soil is suitable as tested, no additional amendments are required. Contractor is not required to correct topsoil conditions beyond soil reaction (pH) and fertility (fertilizer). Contractor shall immediately notify District where unusual topsoil conditions are present that will be harmful to germination.
 - 1. Contractor is not required to adjust soil pH by more than 1.5 points. Topsoil required to be adjusted by more than 1.5 points shall be considered an unusual soil condition and additional amendments shall be provided where authorized by an approved Change Order.
 - 2. The presence of unusual soil conditions affecting fertility, germination, high or low organic content, soil compaction, or similar conditions does not alleviate the Contractor of responsibility to provide suitable growing and germination conditions. Where unusual soil conditions are identified through soil testing, or during the execution of the Work, Contractor shall immediately notify District and propose measures to address deficient soil conditions. Additional Work shall only be performed when approved by Change Order.
- D. All topsoil shall be free of stones, lumps, plants, roots, and other debris over 1-1/2-inches. Topsoil shall be free of weeds, weed seeds, and toxic substances, such as pesticides, that are harmful to plant growth.

2.2 FERTILIZER

- A. All fertilizer shall be uniform in composition, free flowing and suitable for application by mechanical spreaders. Fertilizers shall be delivered in sealed containers showing percentage by weight of all components and shall bear the name, trade name, and warranty of the producer. Application shall be per soil test and as described by Contractor under the provisions of Paragraph 1.6.C.

2.3 LIME

- A. Lime material shall be ground or pulverized limestone that contains at least 50-percent total oxides, calcium oxide plus magnesium oxide. Limestone shall be ground to such fineness that at least 50-percent will pass through a 100-mesh sieve and not less than 98-percent will pass through a 20-mesh sieve. Granular or pelletized lime may also be used subject to the requirements for pulverized limestone. Application shall be per soil test and as described by Contractor under the provisions of Paragraph 1.6.C.

2.4 ORGANIC MATTER

- A. Peat Moss: Type 1 sphagnum peat moss, finely divided with pH of 3.1 - 5.0.
- B. Sedge Peat: Decomposed peat containing no identifiable fibers.

- C. Leaf Compost: Screened and free of trash.
- D. Composted Sewage Sludge: Screened, polymer-dewatered sewage sludge with a pH of 6.2 - 7.2.
- E. Paper Mill Sludge: Screened, natural-dewatered paper mill sludge with a pH range of 6.8 - 8.0.
- F. Municipal Solid Waste: Compost with pH 6.2 - 7.2 that is screened and contains less than 1-percent man-made materials.

2.5 SEED MIX

- A. Seed Mixture: Provide seed mixtures in accordance with the following schedule:

General Turf Mixture (A)		
Proportion of Mix	Species	Seeding Rate for Mix
40%	Perennial Ryegrass Cultivar	
40%	Perennial Turf-type Fescue Cultivar	
15%	Kentucky Bluegrass Cultivar	
5%	Annual Ryegrass	
		6 – 8 lbs./1,000 SF

Temporary Erosion Control Seeding		
Proportion of Mix	Species	Seeding Rate for Mix
100%	See approved ESC plans	See approved ESC plans

- B. Apply all seed mixtures at half-rates in two cross-directions.

2.6 SOD MIX

- A. Provide sod having the same proportion of varieties as indicated for the seed mix for the area in which the sod is to be installed.
- B. Provide only state-approved sod.
- C. Provide machine cut sod with maximum deviation from width and length being 5-percent. Broken pads and torn or uneven ends are not acceptable.
- D. Do not provide sod that has been harvested or transplanted under drought conditions.
- E. Sod shall be harvested, delivered, and installed within a period of 36-hours

2.7 MULCHING MATERIALS

- A. Straw: Free of rot, mildew, noxious weed seeds and shall be small-grained, such as wheat or barley. Apply at a rate to lightly cover soil, approximately 100 lbs. per 1,000 square feet.
- B. Cellulose Fiber: Specially prepared cellulose processed into a uniform fibrous physical state. The fiber mulch, including dye, shall not contain germination or growth inhibiting factors. The material shall be manufactured and processed in such a manner that the cellulose fiber mulch will remain uniform in suspension in water under agitation and will blend with seed, fertilizer, and other additives to form homogenous slurry. The mulch shall cover and hold grass seed in contact with the soil without inhibiting growth of the seedlings. Contractor may utilize other mulches, such as recycle paper and wood blend, recycled paper, and companion binding accessories at his discretion in hydro-seeding.

2.8 MULCH ANCHORING MATERIALS

- A. Mechanical Method: Tractor-drawn implement designed to punch and anchor mulch into the soil surface.
- B. Cellulose Fiber: Cellulose fiber shall be applied at a net dry weight of 750 pounds per acre.
- C. Liquid Mulch Binder: Non-asphaltic or petroleum based, Reinco, RMB plus (1-800-526-7687), Finn A 500 Hydro-Stik (1-800-873-3321), or equal capable of controlling wind and water erosion of mulch.
- D. Mulch Netting: Prefabricated wood shaving mat with woven photodegradable netting.

2.9 EROSION CONTROL FABRIC

- A. As specified in Section 31 00 50.

2.10 WATER

- A. Clean, potable, free of chemicals or impurities harmful to germination or turf growth.
- B. The Contractor shall be responsible for supplying water for irrigation. District supplied water will not be available at site.

2.11 FROST BLANKET

- A. UV resistant fabric blanket manufactured to assist in germination equal to Fabriscape Frost Blanket (1-800-992-0550).

2.12 HERBICIDE

- A. Broadleaf: Brominal ME4, or equal.

- B. Pre-emergent: Tupersan, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification: Verify that topsoil has been placed to the minimum depths required and that landscape/finished grading has been performed in accordance with Section 312000, Paragraph 3.7. Failure to properly prepare topsoil for seeding will result in rejection of seeding by District.
- B. Do not sow seed or initiate seeding operations when ground is wet or muddy following a rain event, when the ground surface is excessively dry and dusty, or when wind velocity will result in an uneven distribution of seed.

3.2 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions and in accordance with the topsoil analysis.
- B. Apply other soil amendments as required by the topsoil analysis to provide optimum pH range for seed mix. Provide other amendments when required by soil test or as recommended by Contractor and approved by District.
- C. Apply amendments after raking of topsoil. Mix all soil amendments thoroughly and evenly into upper two-inches of soil. Lightly water following application to assist in dissipation of fertilizer.
- D. Do not apply fertilizer with same equipment used for seeding.

3.3 SEEDING

- A. Dry Application:
 - 1. Sow seed at the rates specified in one-half rates evenly in two intersecting directions. When using a broadcast or drop-type spreader, rake in lightly to insure good soil/seed contact. Soil shall be applied with the top ¼-inch of the soil. A cultipacker may also be used following broadcast seeding to improve soil/seed contact or alone as the method of dry seeding.
 - 2. Manually sow seed where areas are not accessible to mechanized seeding equipment. Seed shall be evenly distributed and rake in to the top ¼-inch of the soil.
 - 3. Mulching: Apply mulching material to retain moisture and minimize erosion. Apply straw mulch at a rate to provide ½ to 1-inch-thick layer, approximately equal to 100 pounds/1,000 SF or 80-100 bales per acre. When using cellulose fiber as a mulching material, apply at 1,500 pounds per acre. Anchor mulch according to referenced methods.
 - 4. Apply water with a fine spray after each seeded area has been mulched. Water sufficiently to saturate upper three – four inches of topsoil.

5. Place signs, rope off, or otherwise protect newly seeded areas from encroachment. Maintain protection until seeded areas are accepted by District.

B. Hydroseeding

1. Mix water, seed, and fertilizer and agitate to homogeneously blend mixture. Contractor shall determine appropriate ratios to meet required seeding application rates as specified and fertilization rates as determined by the soil test.
2. All mixtures shall be constantly agitated from the time they are mixed until they are finally applied to the seedbed. To prevent fertilizer from burning seed, the slurry shall be applied within 30-minutes from the time it was added to the hydroseeding mix.
3. Following hydroseeding, utilize a straw blower to apply mulch. Hand mulch areas around trees, shrubs, landscape beds, and other areas where straw mulch is not desired. Apply at the rates specified in Section 3.3.A.3.
4. Cellulose fiber may be included in the hydroseeding mix for seeding embankments and steep slopes. All slopes greater than four horizontal to 1 vertical (4:1 or 25%) may be hydroseeded by the seed, fertilizer, water, and cellulose fiber method. All other areas shall be dry seeded or hydroseeded using straw mulch for stabilization as described in paragraph 3.3.B.1-3. The rate of cellulose fiber shall be 50 pounds per 100 gallons of water or as otherwise recommended by the County Agriculture Cooperative Extension.
5. Protect seeded areas as described in Section 3.3.A.5.

C. Reseeding and Overseeding

1. During grow-in period, immediately repair areas that have washed or become eroded and perform additional measures as required to stabilize. When directed by District, as authorized by a Change Order, sod may be installed at areas where stabilization is difficult.
2. Where areas have failed to germinate, Contractor shall overseed or slit-seed bare areas. Method of seeding shall depend on size of area to be reseeded and time of year. All areas seeded after the fall planting season shall be overseeded in the Spring at a rate equal to one-half of the original seeding rate. Overseeding shall be performed when authorized under the provisions of Section 1.13.B.

3.4 SODDING

- A. Verification: Verify that grading is complete and area is ready for sodding.
- B. Lightly irrigate the soil prior to laying the sod.
- C. Lay the first row of sod in a straight line with subsequent rows placed parallel a tight. Lateral joints shall be staggered to promote uniform growth. Do not stretch or overlap sod. Shape sod to form to the line and contour of play areas or infield areas when required. Edge sod if required to form clean line.
- D. Lightly water sod during installation to prevent drying. Roll sod as sections are completed.

- E. Thoroughly irrigate sod following installation so that the entire sod pad is wet and soil below the pad is wet.
- F. Continue to water until sod is well established. Keep sod moist at all times for the week following installation. Watering may be required several times a day. Continue watering until sod is well rooted.

3.6 EROSION CONTROL

A. Temporary Seeding

- 1. Perform temporary seeding and mulching work when required to stabilize construction areas in accordance with the requirements of the Erosion and Sediment Control Plan.
- 2. Prior to final seeding, any temporarily seeded area shall have the existing stand of turf completely killed to prevent invasive growth of the temporary seed variety in the final seeding.

B. Geotextile Fabric

- 1. Install geotextile fabric of type designated on the Drawings for all newly seeded slopes greater than or equal to three horizontal to one vertical (3:1 or 33%).
- 2. Install geotextile fabric of type designated on Drawings for newly graded swales, drainage channels, and detention basin spillways where indicated on the Drawings. Geotextile swale linings indicated on the Drawings have been provided based upon their erosion resistance as compared to the calculated flow velocities for the channel. Where a geotextile lining is not indicated on Drawing, the calculated velocity for that swale is less than 2.0 feet per second and is not considered an erosive velocity under PADEP Chapter 102 Standards. When geotextile stabilization is not indicated, Contractor, at his discretion, may provide a photodegradable or biodegradable seed blanket to assist in germination and reduce the potential for repair and reseeding of the channel due to unanticipated flow velocities. Contractor is responsible for regrading, providing additional topsoil, and reseeding any areas that have washed or eroded regardless if geotextile lining is indicated on the Drawings.
- 3. Install geotextile fabric immediately following seeding to reduce the potential for accelerated erosion and seed loss.
- 4. Securely lap edges of fabric, provide velocity checks, trench and tuck ends of fabric, and securely staple and stake fabric at intervals recommended by the manufacturer. Manufacturer's instructions and specifications, as approved by District, shall be considered the minimum requirement for execution of the Work.

3.7 MAINTENANCE

- A. The Contractor shall perform all maintenance until the required growing condition is present as specified in Section 1.13.A and Substantial Completion has been established. Notify District a

minimum of three days in advance prior to performing any maintenance operation. Maintenance includes the following:

1. Edging: Edge along perimeter of all sidewalks, paved areas, landscape beds, infield areas, and slabs a maximum of three days prior to request for Substantial Completion inspection.
2. Mowing: Cool season grasses, including bluegrass, tall fescue, and perennial ryegrass shall be maintained at a height of 2-1/2- inches to 3-1/2-inches in the spring and fall. During the summer, the mowing height shall not be less than three-inches. No more than 1/3 of the blade shall be removed in a single cutting.
 - a. The Contractor shall perform a minimum of one mowing a minimum of three days prior to requesting an inspection for Substantial Completion for any turf area included in the request for Substantial Completion inspection.
 - b. During the period from initial seeding through Substantial Completion, the Contractor shall be required to mow any contiguous area of grass greater than fifty square feet, including partially completed areas of seeding, when the average height of the grass in the fifty square foot area exceeds four-inches.
3. Fertilizing: Contractor shall fertilize seeded areas as required to assist in germination and establish a thick, healthy stand of grass until Substantial Completion is established. Fertilization shall be based upon the requirements of the turf species, time of year, and soil test results. Contractor shall be responsible for obtaining additional soil test results when required for fertilization between initial seeding and establishment of Substantial Completion.
4. Lawn/Weed Control: The Contractor shall apply a pre-emergent soil applied herbicide for all spring and summer seedings to control the germination of crabgrass and other annual weed seeds. Prior to a request for Substantial Completion inspection, a post emergent, foliar applied, herbicide shall be applied to prevent the growth of broadleaf weeds in mid to late May to control summer weeds and in late September or early October to control fall weeds. Selection and proper use of herbicides is the Contractor's responsibility. All chemical applications shall be performed under the supervision of a licensed certified applicator.
5. Insect and Disease Control: The Contractor shall be responsible for monitoring all newly established lawn areas for insect damage and disease and taking any corrective measures as required. The Contractor shall only be responsible for disease and insect control until Substantial Completion is established.
6. Watering: The Contractor shall be responsible for maintaining sufficient moisture in the soil during germination and as required for turf establishment until Substantial Completion. The Contractor is not required to water any seeded areas but accepts responsibility for the failure of germination, slow germination, unhealthy stands of grass, or sparse vegetation that increases his maintenance responsibilities until substantial completion can be established.

7. Repair: Repair all areas that have washed or eroded, correct surface irregularities for areas that have settled and pond water, and remedy damage from improper use of herbicides or over fertilization.

END OF SECTION

SECTION 32 93 00 – PLANTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Exterior trees, shrubs, and plants.
- B. Fertilizer, plant mix, mulch, and planting accessories.
- C. Tree grates, tree guards, root barrier systems.
- D. Pruning.
- E. Maintenance required after planting until Substantial Completion.

1.2 RELATED SECTIONS

- A. Division 1 – General Requirements
- B. Section 31 00 50 – Basic Site Materials and Method
- C. Section 31 20 00 – Earth Moving

1.3 STANDARDS

- A. All plant material shall conform to the latest edition of the American Standard for Nursery Stock, ANSI Z60.1 – Nursery Stock.
- B. All plant material shall be provided from nurseries that have been certified by state plant inspectors.
- C. All chemical applications shall be performed in accordance with current local, state, and federal regulations utilizing EPA registered materials and methods of application. All chemical applications shall be performed under the supervision of a Licensed Certified applicator.

1.4 SUBMITTALS

- A. State nursery inspection certificates, current within last twenty-four months, for each nursery supplying Contractor with plant material.
- B. Product Data: Submit product data, manufacturer's installation instructions and specifications, standard color samples, catalog cuts or manufacturer's standard shop drawings.

1.5 DEFINITIONS

- A. Weeds: Dandelion, Jimsonweed, Quackgrass, Horsetail, Morninglory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy, Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.
- B. Plants: Living plants meeting the requirements of ANSI Z60.1.
- C. Shrub Massing: Three or more plants, regardless of species, consecutively grouped together whether in formal or random pattern.

1.6 SUBSTITUTIONS

- A. Pre-bid: The Contractor shall make every reasonable effort to find the landscape materials specified. Contractor is not required to verify if materials exist at nurseries beyond a 100-mile radius from the project site. Contractor shall make recommendations for substitutions if desired plant material is unavailable, or, in the Contractor's opinion, unsuitable for the site, location to be planted, or other reasons that may result in the failure of the plant. The Contractor shall also notify the Architect if disease resistant or insect resistant species can be substituted for the selected pest-prone plant.
- B. Post-Bid: Requests for substitutions following bid shall be approved by the Architect. Contractor shall submit request in writing, state the reasons for the substitution, and state the material to be substituted. Substitute material following the bid, shall be provided at no additional cost to the Owner.

1.7 QUALITY ASSURANCE

- A. Nursery Qualifications: Company specializing in growing and cultivating plants with ten years documented experience and having plant materials that have been inspected and certified within twenty-four months by state plant inspectors.
- B. Installer Qualifications: Company specializing in installing plants and landscaping with ten years documented experience.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not install plants when ambient temperatures may drop below 35 degrees F or rise above 90 degrees F.
- B. Do not install plant life when wind velocity exceeds 30 MPH.

1.9 UNDERGROUND UTILITIES

- A. Contractor shall notify utility companies prior to any excavation in accordance with PA Act 138 and in accordance with Section 31 20 00.
- B. Where a conflict exists with a location of a utility line, the Contractor shall notify the Architect. Contractor is responsible for damage to any charted utility lines and utility lines installed as part of the Work. All utility lines shall be repaired in accordance with Section 31 20 00.

1.10 DRAINAGE

- A. Where Contractor finds through site inspection that plant materials will be installed in areas that exhibit poor drainage and the plants are inappropriate for that condition, the Contractor shall notify the Architect. The Architect shall either relocate the plant material to an appropriate location, accept a suitable alternate as proposed by the Contractor, or authorize the Contractor through a Change Order to make necessary improvements to alleviate the poor drainage condition.

1.11 PLANTING SEASONS

- A. The Contractor is responsible for scheduling the Work to permit installation of plant materials at the optimum planting times for each particular plant species. Plant material moved outside of the normal planting season may require special treatment and shall be performed at no additional cost to the Owner.
- B. Stress Chart for B&B Deciduous Material

Lowest Risk	1. Deciduous plants dug and planted while dormant in spring or fall excluding those listed in 1.11.H. 2. Deciduous plants dug during dormancy and planted after producing leaves providing they have been properly stored. 3. Deciduous plants dug after leaves have fully expanded and hardened off.
Highest Risk	1. Deciduous plants dug in the spring during newly expanding leaf production.

- C. Freshly dug evergreen material shall not be moved without proper conditioning during active growth.
- D. All plant material dug in summer full foliage shall be handled in one of the following methods:
 - 1. Properly harden-off in the field 7-10 days prior to digging by the gradual process of trenching and soaking, leaving the bottom surface of the ball attached to soil until shipping.
 - 2. Condition under irrigation in partial shade or sun for at least four days prior to shipping.

- E. Container-grown material and hardened-off B&B evergreen or deciduous material can be planted year-round in unfrozen ground.
- F. Perennials can be installed as soon as ground is workable in the spring until November 15. Plants installed after November 15 require a protective, supplemental mulch applied after December 15 and removed March 15.
- G. Cold sensitive annuals can be installed after danger of frost has passed.
- H. Spring-flowering bulbs can be installed between September 15 and December 15.
- I. Red, White, Willow and Scarlet Oaks, Dogwood, Sweet Gum, and all conifers, excluding White Pine, shall not be planted between November 15 and March 15.

1.12 INSPECTION AND ACCEPTANCE

- A. Plant Materials: Architect reserves the right to inspect all plant materials at nursery prior to delivery to project site. Contractor shall tag all materials at nursery a minimum of two weeks prior to delivery and notify Architect that materials are available for inspection. Architect shall not reject any materials delivered to site, excluding material damaged during delivery or due to handling, due to failure to conduct inspection at nursery.
- B. Inspection: Upon completion of the Work, or completion of areas equal to at least twenty-five percent of the total quantity of exterior plant installation, the Contractor shall request an inspection to determine substantial completion. Request shall be made by the Contractor to the Architect in writing and Architect shall complete inspection within two weeks of receipt of request for inspection. Contractor shall clearly note in request for inspection which areas are substantially complete if not requesting inspection for the entire installation.
 - 1. Architect shall issue a notice of Substantial Completion following inspection where plant installation is substantially in conformance with the specified requirements and Drawings. Minor deficiencies shall be noted and Contractor shall correct all deficiencies within two-weeks of receiving notice.
 - 2. Where Architect determines that Work is not substantially complete due to significant deficiencies, Contractor shall take immediate corrective action. Upon completion of corrective measures, Contractor shall again request inspection to determine if Substantial Completion has been obtained.
- C. Contractor shall perform required maintenance as described in Section 1.15 immediately prior to requesting inspection to determine Substantial Completion. Architect will not inspect plantings that have not been maintained or are not neat in appearance. Substantial Completion will not be evaluated solely upon the appearance and growing condition of the plant.

1.13 WARRANTY

- A. Warranty all plant materials for one year following the date of the notice of Substantial Completion. The Architect shall review all materials two-weeks prior to the end of the warranty period and notify the Contractor in writing if any material shall be replaced at the Contractor's expense.
- B. Any material that is twenty-five percent dead shall be considered dead and must be replaced. A tree shall be considered dead when the main leader has died back, or twenty-five percent of the crown is dead.
- C. Contractor is not responsible for replacing material that has been damaged by the Owner, or as a result of the Owner's failure to execute maintenance procedures following completion of the Contractor's required maintenance period.

1.14 REPLACEMENTS AND CONDITIONS

- A. Replacements shall be made during the next planting period unless the Contractor agrees to an earlier date.
 - 1. Spring: March 15 – June 15, Fall: September 15 – November 15.
- B. The Contractor shall be responsible for a one-time replacement only. Architect, or Owner, shall inspect any replacement material prior to replacement.
- C. Replacements shall be of the same type, size, and quality of the original species unless alternate material has been approved by the Owner.
- D. Contractor is not responsible for plant material that has been damaged due to vandalism, fire, removal, theft, wildlife, or improper maintenance by Owner. Plant losses due to abnormal weather conditions such as floods, excessive winds, severe freezing, or abnormal rainfall is not the responsibility of the Contractor.
- E. The Contractor is not required to warranty or replace existing transplanted material. Contractor shall perform installation and maintenance for all transplanted material as required for new material.

1.15 MAINTENANCE SERVICE

- A. Maintain plants immediately after placement until Substantial Completion is established as defined in Paragraph 1.12.B. Owner shall be responsible for all plant maintenance following date of Substantial Completion.
- B. Maintenance shall include cultivation and weeding of tree pits, application of herbicides, irrigation, pruning, disease control, maintenance of tree wrappings, guys, and turnbuckles, edging planting beds, and replacement of mulch.

PART 2 - PRODUCTS

2.1 PLANTS

- A. Plants shall be in accordance with the referenced standard and conform in general to representative species.
- B. Bare Root:
 - 1. Bare-rooted shrubs shall be dug with adequate fibrous roots.
 - 2. Roots shall be protected during handling and planting to guard against drying out and damage.
 - 3. The use of bare-root perennials and ground cover (rooted-cuttings) shall be limited to optimal planting times.
- C. Balled and Burlapped (B&B):
 - 1. Balled and burlapped plants shall be dug with firm root balls free of noxious weeds. There shall be no excess soil on top of the root ball or around the trunk.
 - 2. Ball sizes shall be in accordance with the referenced standard.
 - 3. Caliper and Height Measurement: In size grading B&B single-trunk trees, caliper shall take precedence over height. Caliper of tree trunk shall be taken 6-inches above the ground level for trees up to 4-inches caliper and 12-inches above the ground level for trees larger than 4-inches caliper. For multiple-trunk trees, height shall take precedence over caliper.
- D. Container Grown Stock:
 - 1. The size of container-grown shrubs is measured by the height and width of the plant. Herbaceous perennials shall be measured by pot size, not top growth. The root system of container-grown plants shall be well-developed and well-distributed throughout the container such that the roots visibly extend to the inside face of the growing container.
 - 2. All container-grown shrubs that have circling and matted roots shall be cut with a sharp knife as required to cut all circling roots a maximum of one-inch deep.
 - 3. All container-grown plants shall be grouped and watered daily until they are planted.
- E. All plant material shall be nursery grown. Pruning shall be done before planting or during the planting operation.
- F. All plant material in transit shall be covered to keep material from drying out.

2.2 ORGANIC MATTER

- A. Peat Moss: Type 1 sphagnum peat moss, finely divided with a pH of 3.1 - 5.0.
- B. Sedge Peat: Decomposed peat containing no identified fibers.

- C. Leaf Compost: Screened and free of trash.
- D. Composted Sewage Sludge: Screened, polymer-dewatered sewage sludge with a pH range of 6.8 – 8.0. Sewage sludge is recommended for solid plantings of non-ericaceous materials.
- E. Pine Bark: Potting grade pine bark with no particle size larger than ½-inch and less than 10-percent wood fiber.
- F. Municipal Solid Waste: Compost with pH of 6.2 – 7.2 that is screened and contains less than 1-percent man-made materials.

2.3 TOPSOIL

- A. On-site available topsoil or approved imported topsoil as specified in Section 310050. The Contractor shall be responsible for providing satisfactory topsoil as required to meet the necessary quantities for the Work.
- B. Soil Testing: Soil tests shall be done prior to planting. The soil test shall include a mechanical analysis and determine the levels of magnesium, potassium, phosphorous, soluble salt, pH, and organic matter. The Contractor shall be responsible for providing sufficient number of tests to determine representative analysis of topsoil. Topsoil shall not be tested until it has been stripped and stockpiled. All imported topsoil shall be approved by the Architect before the material is delivered to the site.
- C. Soil Amendments: Contractor shall amend topsoil as determined by the soil tests to provide suitable topsoil for sustaining plant growth. The Contractor is not required to correct unusual soil conditions beyond the specific areas of testing as identified in Paragraph 2.3.B. Contractor shall immediately notify Architect where unusual topsoil conditions are present that will be harmful to plant growth.
- D. All topsoil used in planting shall be free of stones, lumps, plants, roots, and other debris over 1-1/2-inches. Topsoil shall also be free of weeds, weed seeds, and toxic substances, such as pesticides, that are harmful to plant growth.

2.4 FERTILIZER

- A. All fertilizer shall be granular pills, packet, or pellet with 35 percent to 80 percent of the total nitrogen in a slow release form.
- B. Trees, Shrubs, and Ground Cover: Fertilizer shall be complete with a minimum analysis of 10% nitrogen, 6% phosphorus, and 4% potassium.
- C. Perennials, Annuals, Bulbs: Fertilizer shall be complete fertilizer that is slow released.

- D. Fertilizer shall be added, except when compost is used to amend soil, depending on the size of the plant and the manufacturer's recommendation. The following are recommended application rates.

1. Trees: Use 1 to 3 pounds of actual nitrogen contained in a complete fertilizer per 1,000 square feet of treated area.
2. Shrubs: Use ½ pound of actual nitrogen contained in a complete fertilizer per 100 square feet of bed area.
3. Ground Cover: Use ¼ pound of actual nitrogen per 100 square feet of bed area.
4. Perennials, Annuals, Bulbs: Use 3 pounds of time-released, high phosphate fertilizer per 100 square feet of bed area.

2.5 BACKFILL MIXTURE

- A. Backfill mixture for trees and shrubs shall consist of well blended mixture of 3 parts topsoil and 1 part organic material, plus granular fertilizer. When compost is used, omit granular fertilizer.

2.6 MULCH

- A. Organic Mulch: Material shall be composted, shredded hardwood bark mulch, pine bark with less than 10% sapwood, dark brown in color, or approved equal.
- B. Stone Mulch: White decorative river stone, washed free of loam, sand, clay, and other foreign substances ranging in size from 3" maximum to 1" minimum to match existing stone mulch located on the property.

2.7 GEOTEXTILES

- A. Weed Barrier (Organic Mulch): Geotextile as specified in Section 31 00 50.
- B. Weed Barrier (Stone Mulch): Geotextile as specified in Section 31 00 50.

2.8 WATER

- A. Clean, potable, free of chemicals or impurities that are harmful to plant growth.
- B. The Contractor may use water from the site for irrigation of plants.

2.9 PLANTING ACCESSORIES

- A. Stakes: 2" x 2" hardwood or equal. Length as required for proper tree support.
- B. Wire: 12 or 14 gage galvanized steel or equal, depending on size of tree.
- C. Turnbuckles: Galvanized steel or zinc coated, size as required for proper tree support.

- D. Hose: Corded rubber, ½-inch or ¾-inch depending on size of tree. Straps, plastic locks, and other acceptable methods may also be used.
- E. Clamps: Galvanized, zinc or vinyl-coated appropriate in size to hold wire or cable.

PART 3 - EXECUTION

3.1 PLANTING PROCEDURE FOR TREES

A. Preparing Tree Pit

1. Walls of tree pit shall be dug so that they are vertical, or sloping outward in heavy soils, and scarified.
2. The tree pit shall be a minimum of 9-inches larger on every side than the root ball.
3. The tree pit shall be dug so that 1/8 of the ball extends above existing grade with the base of the ball resting in the tree pit. The ball shall rest upon undisturbed existing soil or compacted backfill.
4. Pits for bare-root trees shall only be broad enough to accommodate the roots fully extended and only deep enough so that the upper most roots will be approximately one-inch below final grade.
5. Where planting in soils that are high in clay content or where drainage will be poor, notify the Architect. The Architect shall determine if subdrainage shall be installed, the tree relocated, or soil conditioned to permit proper drainage. The Contractor shall be responsible for replacing the plant material if unsuitable conditions are present at the time of planting and the Architect was not notified.

B. Placing Tree in Pit

1. Place tree in the pit by carrying the ball and the lowering the tree into the pit by the ball. Never lift the tree by the trunk or the branches.
2. Set the tree straight and in the center of the pit with the most desirable side facing toward the prominent view.
3. For bare-root trees, set the tree in the pit so that the roots, when fully extended, will not touch walls of the pit and so that the uppermost root is approximately one-inch below grade.
4. Remove containers from all container-grown stock. Slash the edges of the root balls from top to bottom at least one-inch deep as described in Paragraph 3.3.
5. Root containment grown trees shall have the root containment bag removed before placing the tree in the planting pit.

C. Backfilling Tree Pit

1. Backfill tree pit with plant backfill mixture.
2. Cut and remove rope or wire from the top one-half of the rootball and pull burlap back to the edge of the ball. Remove as much burlap, woven products, and twine as possible.

- All plastic or synthetic film must be removed from the rootball. Cut all twine away from the trunk.
3. Thoroughly mix all soil amendments, where needed, prior to filling tree pit.
 4. Backfill sides of tree pit halfway with soil mixture and tamp as pit as being filled. Do not excessively compact final pit backfill. The tree must remain straight during backfilling.
 5. Never cover the top of the rootball with soil.
 6. Form a saucer above existing grade, around the outer rim of the tree pit. The saucer is especially critical when planting on slopes and in heavy soils.
 7. Mulch top of rootball and saucer to a minimum depth of two-inches and not to exceed three-inches. Do not place mulch against trunk.
 8. Water thoroughly on the interior of the tree saucer until it is filled, even if planting has occurred in rain. A second watering may be required to insure saturation of the rootball and elimination of air pockets. As an alternative, the contractor may backfill one-half of the pit and flood the pit with water prior to replacing the remaining backfill.
 9. Pruning shall be done after the tree is in place as described in Paragraph D.
- D. Pruning: Initial pruning of trees shall be performed as part of planting operations on all new nursery stock. Pruning as part of maintenance operations shall be performed as described in Paragraph 3.7.
1. Pruning as part of planting procedures shall be restricted to corrective pruning only.
 2. Do not cut main leader.
 3. Make all cuts back to a lateral branch or bud.
 4. Pruning shall be done with the tree in place.
- E. Tree Staking:
1. The decision for staking shall be made on an individual tree basis and shall not be required for all trees in the Contractor's discretion do not require staking. Trees that are not in a straight and upright condition at the end of the warranty period due to the failure of the Contractor to provide adequate support shall be replaced by the Contractor.
 2. Staking shall be completed as soon as possible following planting. Provide staking as scheduled. Place stakes parallel to walks and buildings.
 3. Space stakes evenly and vertically on the outside over the tree ball and drive firmly into the ground. Stakes shall be driven at an angle and drawn vertical. Never drive a stake through the rootball.
 4. Cut pieces of hose long enough to loop around the tree trunk. Place the hose around the trunk at the height required to provide optimum support. Thread the wire through the hose and pull both ends horizontally 2-feet beyond the stake.
 5. Twist the wire at the rubber hose to keep it in place. Wind both ends of the wire together around the stake twice and then twist wire back on itself to secure. Cut off excess wire. The wire shall be approximately 2'-6" from the top of the stake. Proper staking should allow for a one-inch to three-inch sway in the tree.
 6. The Contractor may use tree straps in place of rubber hose and wire at his discretion. Follow manufacturer's instructions when using tree straps.

7. All stakes, hose, and wire must be removed one-year after planting unless growing conditions warrant otherwise. The Owner shall be responsible for removing all stakes, hose, and wiring at the end of the warranty period.

F. Tree Guying

1. The decision for guying shall be made on an individual tree basis and shall not be required for all trees in the Contractor's discretion do not require staking. Trees that are not in a straight and upright condition at the end of the warranty period due to the failure of the Contractor to provide adequate support shall be replaced by the Contractor.
2. Guying shall be completed as soon as possible following planting. Provide guying as scheduled.
3. Cut lengths of hose to extend two-inches past tree trunk when wrapped around.
4. Space stakes evenly on outside of the tree saucer and drive each firmly into the ground. Stakes shall be driven at a 30-degree angle with the point of the stake toward the tree, with 4-inches remaining above grade.
5. Place the hose around the trunk just above the lowest firm branch. Thread the wire through the hose and pull down the wire to extend two-feet beyond the stake.
6. Twist the wire at the rubber hose to keep it in place. Wind both ends of the wire together around the stake twice and then twist wire back onto itself to secure. Cut off excess wire. The wire shall be two-inches from the top of the stake. If necessary, twist wires to tighten the guy.
7. Flag the guy wires with surveyor's flagging tape or equal.
8. All stakes, hose, and wire must be removed one-year after planting unless growing conditions warrant otherwise. The Owner shall be responsible for removing all stakes, hose, and wiring at the end of the warranty period.

G. Tree Guying with Prefabricated Cable Systems

1. The decision to use prefabricated guying and cable systems shall be at the Contractor's discretion for all trees less than twenty feet in height. All trees greater than twenty feet shall be guyed using a prefabricated cable and guying system.
2. Anchoring shall be as completed as soon as possible following planting.
3. Drive anchors into the ground to the manufacturer's recommended depth at final desired angle. Do not drive anchors straight into the ground.
4. Set each anchor as recommended by manufacturer, install turnbuckles, and secure into a fixed position. Tighten turnbuckles to permit a one to three-inch sway in the tree.
5. Flag the guy wires with surveyor's tape or equal.
6. The guying system must be removed one-year after planting unless growing conditions warrant otherwise. The Contractor shall be responsible for removing all prefabricated guying and cable systems.

- H. Tree Staking and Guying Schedule: The following schedule is provided as a guideline. The Contractor is solely responsible to ensure that trees are properly supported, maintained in a straight condition, and upright position throughout the warranty period. Evergreens are more likely to requiring staking or guying at any height above four feet. Flowering and shade trees not exceeding eight-feet shall be staked or guyed at the Contractor's discretion.

Height	Caliper	Stake	Number	Wire or Cable	Turnbuckle	Hose
6'-8'	1-1 ½"	5' upright	2	14 gage wire	-	½"
8'-10'	1-1 ½"	5-6' upright	2	14 gage wire	-	½"
10'-12'	2-2 ½"	7-8' upright	2	14 gage wire	-	½"
12'-14'	2 ½-3"	2' guy	3	12 gage wire	-	½"
14'-16'	3-4"	2' guy	3	12 gage wire	-	¾"
16'-20'	4-6"	30" guy	3	12 gage wire	-	¾"
>20'	>6"	Anchor	3	Cable	3/8"-6"	¾"

3.2 PLANTING PROCEDURES FOR SHRUBS

A. Planting Shrubs

1. For individual shrubs, the pit shall be a minimum of twelve-inches larger on every side than the root ball. The pit shall be dug so that 1/8 of the ball extends above existing grade with the base of the ball resting in the shrub pit. The ball shall rest upon undisturbed existing soil or compacted backfill.
2. For a shrub mass planting, the entire bed area shall be tilled four to six-inches deep. Tilling shall only be done in dry soil to avoid compaction. If the soil is heavy in clay and silt, organic mater should be added. Each shrub pit shall be excavated for the proper setting of the rootball. Following tilling, install geotextile weed barrier for all deciduous and semi-evergreen shrub massing's.
3. Place the shrub in the pit by lifting and carrying it by the rootball. Remove containers from all container-grown stock, slash the edges of the rootball from the top to bottom at least one-inch deep.
4. Set the shrub straight and in the center of the pit with the most desirable side facing toward the prominent view.
5. Backfill shrub pit using plant backfill mixture. The shrub must remain straight during backfilling.
6. Thoroughly mix all soil amendments, where needed, prior to filling shrub pit.
7. Backfill sides of shrub pit halfway with soil mixture and tamp as pit as being filled. Do not excessively compact final pit backfill. The shrub must remain straight during backfilling.
8. Cut and remove rope or wire from top one-half of rootball and pull burlap back to the edge of the ball. Remove as much burlap, woven products, and twine as possible. All plastic or synthetic film must be removed from the rootball. Cut all twine away from the trunk.
9. Never cover the top of the rootball with soil.

10. Form a saucer above existing grade, around the outer rim of the shrub pit. The saucer is especially critical when planting on slopes and in heavy soils.
11. Mulch top of rootball and saucer to a minimum depth of two-inches and not to exceed three-inches. Do not place mulch against trunk.
12. Water thoroughly on the interior of the saucer until it is filled, even if planting has occurred in rain. A second watering may be required to insure saturation of the rootball and elimination of air pockets. As an alternative, the contractor may backfill one-half of the pit and flood the pit with water prior to replacing the remaining backfill.
13. Prune out any dead or broken branches.
14. Provide plant tag identifying plant genus and species secured to branch with string, twine, or wire. Secure to prevent dislodging by wind or rain.

B. Planting Bare-Root Material

1. The pit shall only be dug broad enough to accommodate the roots fully extended and only deep enough so that the uppermost roots are approximately one-inch below final grade.
2. Set the plant in the pit so that all roots, when fully extended, will not touch the walls of the planting pit and the uppermost roots are just below the original grade.
3. Spread out the roots properly and work plant backfill mix around the roots. Prune off broken roots in a natural position. Water thoroughly while backfilling.
4. Complete backfilling, provide saucer and mulch, prune, and complete installation as described in Paragraph A.

3.3 PLANTING PROCEDURE FOR GROUND COVER, PERENNIAL, AND ANNUAL BEDS

- A. Install geotextile weed barrier per manufacturer's instructions. Coverage shall include the entire planting bed.
- B. Prior to planting, biodegradable pots shall be split, and non-biodegradable pots shall be removed. Root system of potted plants shall be split or crumbled.
- C. The plants, either potted or bare-root, shall be installed so that the roots are surrounded by soil below the mulch. Potted plants shall be set so that the top of the pot is even with existing grade. The roots of bare-root plants shall be covered to the crown.
- D. Space plants as scheduled on Drawings. Spacing shall be triangular to insure complete coverage.
- E. The entire planting bed shall be thoroughly watered following planting.
- F. Treat the entire mulched and planted bed with a pre-emergent, soil applied, herbicide. Apply the pre-emergent herbicide only when the foliage is dry to prevent foliar burn.

3.4 PLANTING PROCEDURE FOR BULBS

- A. Preparation of Planting Bed

1. The planting bed shall be loosened when the soil is dry prior to planting and tilling. The depth shall be as required on the bulb species.
2. Organic matter shall be spread over the bed to a depth of two-inches for peat moss or one-inch deep for compost, not to exceed four cubic yards of compost per 1,000 square feet, after the soil has been loosened. The organic matter shall be worked into the soil by tilling.
3. Fertilizer shall be incorporated into the soil to the planting depth of the bulb. The fertilizer rate shall be based upon the results of the soil test.
4. The entire bed shall be covered with geotextile weed barrier and mulched to a minimum depth of one-inch and a maximum depth of two-inches.

B. Planting Bulbs

1. Bulbs shall be planted using a hand trowel, bulb planter, or power auger. When planting large quantities of bulbs, the planting area may be excavated and then backfilled in lieu of the procedure described in Paragraph A.
2. The bulbs shall be planted so that the basal plate faces down in the planting hole.
3. Spacing of the bulbs shall be as scheduled on the Drawings.
4. The entire planting bed shall be thoroughly watered following planting.
5. Treat the mulched and planted bed with a pre-emergent, soil applied, herbicide.

3.5 TRANSPLANTING

- A. General: Plants designated to be transplanted on the Drawings shall be mechanically excavated using a backhoe or tree spade. Smaller trees and shrubs, or where damage may occur to plants or structures designated to remain shall be manually excavated.

1. Transplanting shall be performed during the scheduled planting seasons when possible. Plants shall only be moved outside of the regular planting season to accommodate the Work schedule and only when approved by the Architect.
2. The Contractor is required to follow recommended planting procedures for all transplanted material and exercise the same care and workmanship as for new material. The Contractor shall notify the Architect five days in advance of any transplanting operations to permit observation of the Work. The Contractor is not required to provide a warranty or guarantee any transplanted material provided the Architect has observed the transplanting Work and acknowledged the performance in terms of the requirements of this Section.

- B. Schedule transplanting to permit trees to be root pruned six-months prior to transplanting.

- C. Tie branches up or down to allow good access during excavation. Prune only those branches that will interfere with the excavation process.

- D. Use a tree spade, or perform excavation of the root system that will provide an equivalent of ten-inches of soil per inch of trunk caliper. If transplanted during the active growing season, provide twelve-inches of soil per inch of trunk caliper.

- E. After lifting tree from the hole, prune root system as required with sharpened hand tools to permit tree to appropriate rest in the tree pit.
- F. Where tree planting will not occur within 24-hours following removal, provide dampened tarp around root and soil system and secure with string, cable, wire, or a standard root basket. Tarp the canopy to prevent water loss from the leaves and stems and store to prevent drying out.
- G. Replant tree where indicated on Drawings. Follow planting procedures described in Section 3.1. Provide tree support as appropriate.
- H. Where transplanting from level to sloped areas, shave the rootball as necessary. Caution shall be taken to prevent unnecessary damage to the existing root system.
- I. Thoroughly water tree following transplanting. Monitor stress on transplanted material and adjust maintenance and watering procedures as required. Request inspection for Substantial Completion only after tree has recovered and is exhibiting vigorous growing condition.

3.6 PRUNING

- A. Pruning Required as Part of Planting Operations: As described in 3.1.D.
- B. Pruning Required as Part of Landscape Maintenance Operations: Perform addition pruning beyond initial pruning required as Part of Planting Operations until Substantial Completion. Owner shall be responsible for all pruning following Substantial Completion.
 - 1. Prune plants that flower before the end of June immediately after flowering. Flower buds develop during the previous growing season and fall, winter, or spring pruning will reduce the flower display.
 - 2. Prune plants that flower in the summer or autumn in winter or spring before new growth begins since these plants develop flowers on new growth.
 - 3. Broadleaf evergreen shrubs shall be hand pruned to maintain their natural appearance after the new growth hardens off.
 - 4. Hedges or shrubs that require shearing to maintain a formal appearance shall be pruned as required. Dead wood shall be removed from sheared plants before the first shearing of the season. Plants shall be sheared vertical for formal hedges or broader at the base to permit better distribution of sunlight.
 - 5. Yews, junipers, hemlocks, arborvitae, and false-cypress shall be pruned after new growth has hardened off in late summer. If severe pruning is necessary, it shall only be done in early spring.
 - 6. Firs and spruces shall be lightly pruned in late summer, fall, or winter after completing growth. Leave side buds. Never cut central leader.

7. Pines shall be lightly pruned in early June by reducing the candles.
8. Groundcover shall be edged and pruned as needed to contain them within their borders.
9. Thinning: Removed branches and water sprouts by cutting back to the point of origin on the parent stem. This method results in a more open plant without stimulating excessive growth.
10. Renewal pruning: Remove oldest branches of shrub at ground, leaving the younger, more vigorous branches. Remove weak stems. On overgrown plants, this method shall only occur over a three year period.
11. Plants overhanging passageways, sidewalks, parking areas, touching buildings, and damaged plants shall be pruned back as required, maintaining a natural appearance to the plant.

3.7 MAINTENANCE

- A. Perform all maintenance as required until Substantial Completion to maintain plants in vigorous growing and healthy condition. Maintenance shall include all procedures as described in Section 1.15.
- B. Owner shall perform all maintenance following Substantial Completion. Contractor shall advise Owner of required maintenance practices, and special practices as may be required, to continue vigorous growing condition and healthy condition through warranty period.

END OF SECTION

SECTION 33 10 00 – WATER DISTRIBUTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Domestic and Fire Water Pipe.
- B. Irrigation pipe and appurtenances.
- C. Fittings, valves, fire hydrants and other related appurtenances.
- D. Public water main construction.
- E. Testing of water lines.
- F. Disinfection of water lines

1.2 RELATED SECTIONS

- A. Division 1 – General Requirements
- B. Division 2 – Selective Structure Demolition
- C. Division 3 – Concrete.
- D. Section 32 30 00 – Site Furnishings.
- E. Section 31 10 00 – Site Clearing.
- F. Section 31 20 00 – Earth Moving.
- G. Section 31 23 19 – Dewatering

1.3 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI A 21.10, Gray-Iron and Ductile-Iron Fittings, 2 through 48 inches, for Water and Other Liquids.
 - 2. ANSI A 21.11, Rubber Gasket Joints for Cast Iron and Ductile Pressure Pipe and Fittings.
 - 3. ANSI A 21.50, Thickness Design of Ductile-Iron Pipe.
 - 4. ANSI A 21.51, Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
 - 5. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.

6. ANSI B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
 7. ANSI B18.2.1, Square and Hex Bolts and Screws, Including Askew Head Bolts, Hex Cap Screws, and Lag Screws.
 8. ANSI B18.2.2, Square and Hex Nuts.
 9. ANSI B18.22.1, Plain Washers.
- B. American Society for Testing and Materials (ASTM):
1. ASTM A 536, Specification for Ductile Iron Castings
 2. ASTM F 477, Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 3. ASTM D 2321, Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
- C. American Water Works Association (AWWA):
1. AWWA C104, Cement-Mortar Lining for Ductile Iron and Gray-Iron Pipe and Fittings for Water.
 2. AWWA C110, Gray-Iron and Ductile-Iron Fittings, 3 inch through 48 inch, for Water and Other Liquids.
 3. AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
 4. AWWA C150, Thickness Design of Ductile-Iron Pipe.
 5. AWWA C151, Ductile-Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
 6. AWWA C153, Ductile-Iron Compact Fittings, 3 inch through 24 inch and 54 inch through 64 inch.
 7. AWWA C502, Dry Barrel Fire Hydrants.
 8. AWWA C509, Resilient Seated Gate Valves 3 in through 12 in NPS, for Water and Sewage Systems.
 9. AWWA C550, Protective Interior Coatings for Valves and Hydrants
 10. AWWA C600, Installation of Ductile Iron Water Mains and their Appurtenances.
 11. AWWA C651, Standard for Disinfecting Water Mains.
 12. AWWA C800, Underground Service Line Valves and Fittings
 13. AWWA C901, Polyethylene (PE) Pressure Pipe, Tubing, and Fittings, 1/2 inch through 3 inch, for Water.

1.4 SUBMITTALS

- A. Shop Drawings and Product Data: Furnish completely dimensioned shop drawings, catalog cut or other data as required to provide a complete description of piping, fittings and other appurtenances specified herein.
- B. Certificates:
1. Certified records or reports of results of shop tests, such records or reports to contain a sworn statement that shop tests have been made as specified.
 2. Manufacturer's sworn certification that pipe will be manufactured in accordance with specified reference standards for each pipe type.
 3. Test results of bacteriological samples following disinfection of water lines.

1.5 QUALITY ASSURANCE

- A. Design Criteria:
 - 1. Use pipe and fittings designed to withstand trench loading and conditions at the various locations.
 - 2. Shop Tests: Factory test all pipe materials. Each pipe manufacturer must have facilities to perform listed tests. The Architect reserves the right to require the manufacturer to perform such additional number of tests as the Architect may deem necessary to establish the quality of the material offered for use.
 - 3. Laboratory Tests: The Architect reserves the right to require that laboratory tests also be conducted on materials that are shop tested. Furnish labor, materials, and equipment necessary for collecting, packaging, and identifying representative samples of materials to be tested and the shipping of such samples to the Testing Laboratory.
- B. Bacteriological Tests: Perform according to requirements of AWWA C651 – Disinfecting of Water Mains
 - 1. Number of Samples Required: 2

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Transport, handle, and store pipe materials and other Products as recommended by the manufacturers to prevent damage and defects.

1.7 SITE CONDITIONS

- A. Environmental Requirements:
 - 1. Keep trenches dewatered until pipe joints have been made and concrete cradle and encasement, if any, have cured.
 - 2. Do not lay pipe in water or on bedding containing frost.
 - 3. Do not lay pipe when weather conditions are unsuitable, as determined by the Architect, for pipe laying work.

1.8 REGULATORY REQUIREMENTS

- A. The existing water system is privately owned by the school district. Connection to the existing water system and the installation of the water line extension shall be coordinated with the district to ensure there are no outages or disruptions to the High School or other buildings served by the system.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Ductile Iron Cement Lined (DICL): Domestic and Fire Protection piping

1. Manufacturers:
 - a. Griffin Pipe Products
 - b. Clow
 - c. U.S. Pipe
 - d. or equal
 2. Pipe: ANSI/AWWA C151/A21.51.
 3. Wall Thickness Class:
 - a. Interior/Exposed Piping: Class 54 unless higher class dictated by manufacturer.
 - b. Exterior Below Grade Piping: Class 52
 4. Fittings:
 - a. Ductile Compact Fittings: ANSI/AWWA C153/A21.53, Class 350, diameter 4" through 16".
 - b. Ductile Standard Fittings: ANSI/AWWA C110/A21.10, Class 250, diameter 18" through 24".
 5. Joints:
 - a. Buried Joints
 - i. Push-on: ANSI/AWWA C111/A21.11.
 - ii. Mechanical: ANSI/AWWA C111/A21.11.
 - b. Exposed/Interior Joints
 - i. Flanged: ANSI A21.15 with ANSI B16.21 1/16-inch thick cloth inspection rubber face gaskets. ANSI B18.2 nuts and bolts.
 6. Cement Lining: Ductile Iron pipe and fittings shall be coated inside with double thickness cement mortar lining (1/8") and seal coated in conformance with ANSI/AWWA C104/A 21.4.
 7. Pipe and Fittings Coating: ANSI/AWWA C151/A21.51, factory coated inside and out with bituminous paint, minimum 1 mil dry thickness.
- B. Polyvinyl Chloride Pipe – PVC AWWA C900
1. Manufacturers
 - a. J-M Pipe, Blue Brute
 - b. Extrusion Technologies, Inc.
 - c. Certainteed
 - d. or equal
 2. Pipe: AWWA C 900, Class 150, DR 18 pressure pipe manufactured to cast iron or ductile iron outside dimensions.
 3. Fittings: Ductile iron as specified under Ductile Iron Pipe elsewhere in this Section.
 4. Joints: ASTM D 3139 compression gasket ring with ASTM F 477 elastomeric seals.
- C. High Density Polyethylene (HDPE) - SDR 9:
1. Manufacturers:
 - a. J. M. Eagle
 - b. Certainteed
 - c. or equal
 2. Pipe: ANSI/AWWA C906, ASTM F714, ASTM D-3035, ASTM D-3350, PE4710, SDR-9, Class 250, NSF 14 and 61 certified.
 3. Fittings: Conforming to same applicable ASTM Specification requirements for pipe.
 4. Joints: Thermal Fused Joints for 4-inch through 2-inch pipe shall be jointed by thermal

butt-fusion in accordance with ASTM D2657 and pipe manufacturer's recommendations. Termination to pump basins, valves, fittings, etc. made of other materials shall be flange assemblies. The pipe adjacent to these joints must be rigidly supported for a distance of one foot beyond flange assembly. Joints for 2-inch pipe shall be by socket fusion in accordance with ASTM D2657 and pipe manufacturer's recommendations.

2.2 VALVES

A. Gate Valves (2-1/2" diameter and larger)

1. Manufacturers
 - a. Mueller.
 - b. American Flow Control
 - c. Or equal.
2. General: AWWA C 509 resilient seat wedge type designed for 150 psi operating pressure.
 - a. Buried: Non-rising stem.
3. Valve Body: ASTM A 126, Class B cast iron.
4. Resilient Wedge: ASTM A 536 ductile iron created with nitrile rubber.
5. Stem: ASTM B 763 bronze with two (2) upper and one (1) lower nitrile rubber O-ring seals.
6. End Connections:
 - a. Buried service: Mechanical joint.
 - b. Interior/Exposed: ANSI B16.1, 125 pound flanged.
7. Provide square operating nut and valve box for buried service. Provide T-wrench for operating buried valves.
8. Provide hand wheel operators for interior/exposed valves.
9. Interior and Exterior Coating: AWWA C 550 fusion bonded epoxy coating, 8 mils minimum.
10. Extension Stems: Provide for each valve buried 4 feet or deeper. Extension stem shall be 1-inch square solid steel and fitted over the valve operating nut. Set top of stem between 6-inches and 3 feet below finished grade.

B. Valve Boxes

1. Manufacturers
 - a. Tyler Pipe, 6850 series
 - b. Bingham & Taylor, Figure No. 4905
 - c. or equal
2. All valves buried in the ground shall be provided with cast iron valve boxes of the Two Piece or Buffalo Type. The valve boxes shall have an adjustable two section screw-type telescoping column and a separate base. The valve box column shall have an inside diameter of 5 inches. Valve boxes shall be furnished with a cover. Mark covers to read WATER. The valve boxes shall be hot coated inside and out with a tar or asphalt compound. For deep installations, provide screw-type extensions as required, designed for use with the valve box furnished.

C. Curb Stops (2" diameter and smaller)

1. Manufacturers

- a. Ford Meter Box Co.
 - b. Mueller Company
 - c. or equal
 - 2. AWWA C800, 300 psig working pressure, ball or curb type valve, bronze body and tee head, double-stem o-rings, compression style inlet and outlet connections suitable for pipe or tubing used.
- D. Curb Boxes
- 1. Manufacturers
 - a. Bingham & Taylor Fig. No. 4901
 - b. Tyler
 - c. or equal
 - 2. Cast iron construction, adjustable, two (2) piece screw type, 2 1/2-inch shaft with inlaid cover and bolt down lid marked "WATER". Length of box and base shall be as required for the actual field conditions encountered. Interior and exterior of boxes shall be hot bituminous coated.
- E. Air Release Valves
- 1. Manufacturers
 - a. Val-Matic Valve Manufacturing Corp., Model 300 Series
 - b. G. A. Industries
 - c. Or equal
 - 2. General: Valves shall function to vent air which accumulates at high points in water main.
 - a. Construction: Cast iron body and cover; stainless steel float and parts.
 - b. Air Release Orifice: Stainless steel
 - c. Size: As shown on the drawings.
 - d. Maximum Working Pressure: 200 psi
 - 3. House air release valve inside precast concrete manhole as shown on Drawings and specified in Section 02530.

2.3 PIPE SPECIALTIES

- A. Steel Pipe Couplings
- 1. Manufacturers
 - a. Dresser, Style 38
 - b. Smith-Blair, Style 411
 - c. or equal
 - 2. Coupling shall consist of a middle ring, two (2) follower rings, two (2) gaskets and a sufficient number of bolts and nuts.
 - a. Middle Ring: ASTM A513 or ASTM A635 steel.
 - b. Followers: AISI C1012 or ASME SA 36.
 - c. Gasket: Resilient wedge-shaped suitable for use with raw sewage and sludge.
 - d. Bolts: AWWA C111/ANSI A21.11.
 - 3. Use transition gaskets designed for making transition to pipe of differing materials.

B. Flanged Adapters

1. Manufacturers
 - a. Smith-Blair, Style 912
 - b. Dresser, Style 127
 - c. or equal
 2. General: Use to connect plain end pipe to flanged equipment. Coupling shall consist of iron body, a follower ring, a gasket and o-ring, and a sufficient number of bolts and nuts.
 - a. Body: ASTM A126 Class B gray iron or ASTM A47 malleable iron. ANSI 150 lb. flange drilling bolt circle, bolt size and spacing.
 - b. Follower: ASTM A47 malleable iron or ASTM A536 ductile iron.
 - c. Bolts: AWWA C111/ANSI A21.11.
 - d. Gasket: Grade 30 rubber
 - e. O-ring: Grade 60 rubber
- C. Service Saddles
1. Manufacturers
 - a. Ford Meter Box Company
 - b. Mueller Company
 - c. or equal
 2. Double strap type suitable for use on new or existing water main material, self sealing gaskets rated for minimum 250 psig working pressure, type 304 stainless steel or ASTM A 536 ductile iron saddle with type 304 stainless steel.
- D. Tapping-Sleeve Assemblies:
1. Contractor shall provide a tapping sleeve and valve in accordance with specifications. Installation shall be in accordance with the manufacturers requirements. (Addendum 3)
- E. Insert Stiffeners
1. Install corporation stops, curb stops and other fittings utilizing insert stiffeners as manufactured by Ford Meter Company or Mueller Company. Secure stiffeners with hose clamps.
- F. Yard Hydrants (Below Grade)
1. Manufacturers
 - a. Zurn, Model 1365,
 - b. Woodford, Model Y95
 - c. Or equal
 2. General: Non-freeze ground hydrant for flush with grade installation, complete with brass casing, all bronze interior parts, bronze seat and replaceable seat washer, non-turning operating rod with free-floating compression closure valve and 1" Female IP inlet connection. Cast iron box with tapped ¼" drain port in the valve housing and hinged cover with operating handle key lock. Verify size of hose connection with the Owner prior to ordering.

2.4 THRUST RESTRAINT

- A. Provide thrust restraint in accordance with methods outlined. Length of restraint as scheduled on Drawings.
 - 1. Concrete Thrust Blocks and Tie Rods: Details as shown on drawings. Concrete shall comply with PADOT Publication 408, Section 704, Type C (3,300 psi compressive strength at 28 days). Tie rods shall be constructed of suitable metal. Metal harness of tie rods shall be galvanized or otherwise rust proofed and shall be painted with bituminous coating after installation.
 - 2. Megalug Retainer Glands: Mechanical joint restraint consisting of follower gland which when actuated imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. ASTM A 536-80 ductile iron follower gland of dimensions such that it can be used with AWWA C153 mechanical joints. Restraining devices shall be of ductile iron, heat treated to a minimum hardness of 370 BHN. Twist-off nuts shall be used to insure proper actuating of the restraint device. Restraint device shall have a 250 psi minimum working pressure with 2:1 minimum safety factor. Megalug retainer gland equivalent to EBAA Iron, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Carefully examine each section of pipe and each pipe fitting before laying in conformance with the inspection requirements of the appropriate referenced standard.
- B. Remove rejected pipe from the site.

3.2 PREPARATION

- A. Clean piping interior and mating surfaces of bell, spigot and gasket before laying. Maintain clean until completed work is accepted.
- B. Touch-up chipped, cracked, or abraded surfaces and finished joints with two coats of the particular coating material.
- C. Perform trenching for water pipe and place pipe bedding as specified in Section 02300 - Earthwork.
- D. Excavate bell holes sufficiently large to permit proper joint making and to insure pipe is firmly bedded full length of its barrel.
- E. Excavate trenches in rock at least twenty-five (25) feet in advance of pipe laying. Protect pipe ends if blasting is allowed.

3.3 LAYING PIPE

A. General Requirements:

1. Lay pipe proceeding upgrade true to line and grades given. Lay bell and spigot pipe with bell end upgrade unless shown otherwise on the Drawings or directed by the Architect.
2. Exercise care to insure that each length abuts against the next in such manner that no shoulder or unevenness of any kind occurs along inside bottom half of pipeline.
3. Center spigot end in bell or socket end of previously laid pipe, shove tight and secure.
4. No wedging or blocking permitted in laying pipe unless by written order of Architect.
5. Before joints are made, bed each section of pipe full length of barrel with recesses excavated so pipe invert forms continuous grade with invert of pipe previously laid. Do not bring succeeding pipe into position until the preceding length is embedded and securely in place.
6. Walking or working on completed pipeline, except as necessary in tamping and backfilling, not permitted until trench is backfilled one-foot deep over top of pipes.
7. Take up and relay pipe that is out of alignment or grade, or pipe having disturbed joints after laying.
8. Take up and replace with new, such in-place pipe sections found to be defective.
9. Take necessary precautions to prevent newly laid pipe from floating as a result water accumulation in the trench; or the collapse of the pipeline from any cause. Restore or replace pipe as necessary.
10. Bed pipes and place backfill as scheduled on Drawings.
11. At the close of each day's work, and at such other times when pipe is not being laid, protect open end of pipe with a close fitting stopper.
12. Cut pipe using only equipment specifically designed for that purpose such as an abrasive wheel, rotary wheel cutter, a guillotine pipe saw or a milling wheel saw. The use of chisels or hand saws will not be permitted. Grind smooth cut ends and rough edges. Bevel slightly, cut end for push-on connections.
13. Where cutting of pipe is necessary, minimum-laying length shall be five (5) feet.

B. Specific Requirements:

1. Install ductile iron pipe, and fittings, and assemble joints according to AWWA C600.
2. Install plastic pipe and fittings, and assemble joints according to ASTM D 2321 for Class 1 bedding material.

C. Joints:

1. Make pipe and fitting joints according to pipe manufacturer's specifications and to specifications previously specified for pipe.
2. Make joints watertight. Immediately repair detected leaks and defects. Methods of repair subject to Architect's approval.

D. Alignment and Grade:

1. Lay and maintain all pipe at the required lines and grades as shown on the Drawings. Place fittings and valves at the required locations with joints centered, spigots forced home, and all valve stems plumb. Do not deviate from the required line and grade, except with the approval of the Architect.
2. Deflect pipe joints where indicated on the Drawings. Deflections shall not exceed $\frac{1}{2}$ of

- pipe manufacturer's recommended maximum allowable deflection.
3. Do not change grade or alignment without Architect's approval.

3.4 THRUST RESTRAINTS

- A. General: Provide thrust restraint at all plugs, caps, tees, and bends (both horizontal and vertical) on pipelines 4 inches and larger.
- B. Concrete Reaction Backing: Place concrete reaction backing between undisturbed solid ground and the fitting to be anchored. The backing unless otherwise shown or directed, shall be located as to contain the resultant thrust force and so that the pipe and fitting joints will be accessible for repair.
- C. Install Megalug retainer gland according to manufacturer's instructions.
- D. Temporary Thrust Restraint: Provide temporary thrust restraint at temporary caps or plugs. Submit details of temporary restraint to the Architect for approval.

3.5 VALVE INSTALLATION

- A. Inspection of Valves: Prior to installation, inspect valves for direction of opening, freedom of operation, tightness of pressure – containing bolting, cleanliness of valve ports and especially seating surfaces, handling damages and cracks. Correct defective valves or hold for inspection by the Architect.
- B. Installation: Set and join to the pipe in the manner previously specified herein in this Section. Provide valves 12-inches and larger with special support, such as crushed stone or concrete pads so that the pipe will not be required to support the weight of the valve. Set valve truly vertical.
- C. Valve Protection: Provide all buried valves with a valve box. Set the top of the valve box neatly to grade unless indicated otherwise on Details shown on Drawings or directed otherwise by Owner or Architect. Do not transfer shock or stress to the valve, and center and plum the box over the wrench nut of the valve. Do not use valves to bring misaligned pipe into alignment during installation. Support pipe in such manner as to prevent stress on the valve.

3.6 FLUSHING OF LINES

- A. Prior to commencing any line testing, thoroughly flush all newly installed lines to remove dirt, rocks and other construction debris that may be present.

3.7 FIELD QUALITY CONTROL

- A. General Requirements: Conduct tests specified herein so that each pipe line installed in the Project is tested to the Architect's satisfaction.

1. Provide tools, materials (including water), apparatus and instruments necessary for pipe line testing.
 2. Conduct tests in the presence of and to the satisfaction of the Architect.
- B. Hydrostatic Testing for Pressure Lines:
1. Leakage Test Requirements:
 - a. After the pipe has been installed as specified, all newly laid pipe, or any valved section thereof, shall be subjected to a pressure of 150 pounds per square inch, or 50% in excess of the normal working pressure, whichever is greater.
 - b. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.
 - c. No pipe installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula,

$$L = \frac{ND \sqrt{P}}{7400}$$

in which "L" equals the allowable leakage in gallons per hour; "N" is the number of joints in the length of pipelines tested; "D" is the nominal diameter of the pipe, in inches, and "P" is the average test pressure during the leakage test, in pounds per square inch gauge. (The allowable leakage according to the formula is equivalent to 11.6 gallons per 24 hours per mile of pipe per inch nominal diameter, for pipe in 18' lengths evaluated on a pressure basis of 150 psi.)

2. Duration of Test: The duration of the test under pressure shall be two hours.
3. Procedure: Each valved section shall be slowly filled with water and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to Architect. Install the pump, pipe connections, and all necessary apparatus, including gauges. Make all taps into the pipe, and furnish all necessary assistance for conducting the tests.
4. Expelling Air Before Test: Before applying the specified test pressure, all air shall be expelled from the pipe. If hydrants or blowoffs are not available at high places, make the necessary taps at points of highest elevation before the test is made and insert the plugs after the test has been completed.
5. Variation from Permissible Leakage: Should any test of pipe laid disclose leakage greater than that specified, locate, repair, and replace the defective joints, pipe or fittings until the leakage is within the specified allowance.
6. Time for Making Test:
 - a. Where any section of a main is provided with concrete reaction backing, the hydrostatic pressure test shall not be made until at least five days have elapsed after the concrete reaction backing was installed. If high early strength cement is used in the concrete reaction backing, the hydrostatic pressure test shall not be made until at least two days have elapsed.
 - b. Architect shall be present during the operating of valves required to fill mains for pressure and leakage test.

- c. Notify Architect of any pressure test and leakage test at least 48 hours in advance. No testing will be authorized unless air temperature is 35 degrees or higher.
 - d. Architect and the Authority shall witness the pressure and leakage tests.
 - e. Provide laboratory calibrated test gauges and measuring devices for the leakage test.
 - f. The section under test shall be brought back to test pressure at one-half hour intervals during the testing. Architect will record both the makeup water amount and pressure at each one-half hour repressurization.
- C. Alignment Test for Pressure Lines:
 - 1. Prior to backfilling of pressure lines, the joint alignment shall be inspected to assure the maximum deflection present in each joint does not exceed the manufacturer's recommendations.
 - 2. Pressure lines that are a portion of a pump discharge system shall be inspected to assure the line is installed at a constant or increasing grade so as to eliminate the possibility for air accumulation at an intermediate high point.
 - 3. Correct all defects to the satisfaction of Architect or Borough prior to backfilling. This shall be completed before the work shall proceed and before acceptance.
- D. Acceptance: Observation of successful testing of manholes, sewers, water lines or force mains by the Architect does not constitute acceptance of the system or any portion thereof. Upon completion of any determined portion of a total system, and successful testing thereof, the Architect may recommend final acceptance to the Owner.

3.8 DISINFECTION OF WATER LINES

- A. General: Disinfect all water lines prior to placing in service.
- B. Forms of Chlorine for Disinfection: Disinfect water lines by either of the methods listed below.
 - 1. Liquid Chlorine: Apply a chlorine gas-water mixture by means of a solution feed chlorinating device in combination with a booster pump for injecting the chlorine gas-water mixture into the main to be disinfected. The person supervising the handling of the chlorine gas shall be thoroughly familiar with and experienced in the handling of chlorine gas and that the equipment to be used is suitable and safe.
 - 2. Calcium Hypochlorite Solution: Prepare a chlorine-water solution of 1 percent available chlorine using granular calcium hypochlorite, and inject or pump this solution into pipeline. A chlorine-water solution of 1 percent available chlorine may be prepared by mixing approximately 1 pound of calcium hypochlorite with 8 gallons of water.
- C. Preparation:
 - 1. Preliminary Flushing: Prior to disinfection, flush the section of pipeline being disinfected as thoroughly as possible with the water pressure and outlets available.
 - 2. Flush after the pressure and leakage tests have completed.
- D. Chlorination:
 - 1. Application of Chlorine: Apply the hypochlorite solution to the water main with a

gasoline or electrically powered chemical feed pump. For smaller applications, the solution may be prepared in a barrel, and then pumped into the main with a hand pump, such as a hydraulic test pump. Apply at a dosage rate such that the chlorine concentration in the water in the pipe has a minimum of 25 mg/l free chlorine.

2. Point of Application: Apply the chlorinating agent at the high end of the pipeline section being chlorinated, and through a corporation stop inserted in the top of the new pipe. If the water for the preparation of the chlorine solution is supplied from a tap on the existing pipeline, a physical break between the injector supply and injector or pump is required.
3. Rate of Application: Slowly pump the chlorine solution into the new pipeline. Chlorine application shall not cease until the entire main is filled with chlorine solution. If requested by Architect, measure the chlorine residual at several points along the section of main being disinfected to insure that the proper dosage and distribution of the chlorine solution is obtained.
4. Prevention of Reverse Flow: If applicable, exercise great care in manipulating valves so that the strong chlorine solution in the line being treated will not flow back into the adjoining water distribution system.
5. Retention Period and Chlorine Concentration: Retain the chlorinated water in the main for at least 24 hours. All valves and hydrants in the section shall be operated in order to disinfect the appurtenances. At the end of the 24-hour period, maintain a 10 mg/l chlorine residual throughout the length of the main.
6. Final Flushing: Following chlorination, thoroughly flush the heavily chlorinated water from the main at its extremities until the replacement water throughout its length, upon test, is proved comparable to the quality of water in the existing distribution system.
7. Point of Discharge: Discharge the chlorine solution from the water main through available outlets, or through taps in the main installed for such purposes. Inspect the area of discharge point thoroughly before discharging the solution. Exercise all due precautions in discharging the chlorine bearing water, since it is extremely toxic.
8. If the possibility of damage to aquatic life is such that special precautions are required, dechlorinate the disinfecting solution before it goes to waste.

E. Bacteriological Tests

1. Employ an independent laboratory certified by the Pennsylvania Department of Environmental Protection (PADEP) to conduct the bacteriological testing.
2. Testing shall be conducted after water has been retained in main following flushing for a minimum of 16 hours. Testing shall be conducted according to Standard Methods using the membrane filter technique.
3. Bacteriological requirements for sample tests are as follows:
 - a. Zero total coliform per 100 ml sample, and;
 - b. Less than 100 non-coliform colonies per 100 ml sample.
4. Owner or Architect may request that the water be tested at any time prior to final acceptance of Work. If water is considered to be bacteriologically unsafe as determined by test results, rechlorinate system and retest.

F. Redisinfection: If the initial disinfection fails to produce satisfactory bacteriological samples, the main shall be reflushed and resampled. If the samples show the presence of coliforms,

then the main shall be rechlorinated.

3.9 DISINFECTION OF WATER LINE CONNECTIONS

- A. General: In cases where it is not possible to disinfect pipe, valves and fittings as specified herein, proceed as follows:
 - 1. Installation of Connections: Take precautions during installation of connections to prevent foreign material and trench water from entering pipe, fittings and valves during installation.
 - 2. Disinfection: Interior of all pipe, fittings and valves shall be swabbed with a 5 percent hypochlorite solution.
 - 3. Flushing: Thoroughly flush pipe, fittings, and valves after they have been swabbed with water.

3.10 PIPING SCHEDULE

- A. Construct water lines using the materials noted on the Drawings.

END OF SECTION

SECTION 33 30 00 – SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Sanitary sewer pipe and fittings.
- B. Sanitary sewer manholes.
- C. Duplex Grinder Pump Stations
- D. Related appurtenances

1.2 RELATED SECTIONS

- A. Division 1 – General Requirements
- B. Division 2 – Selective Structure Demolition
- C. Division 3 – Concrete.
- D. Section 31 10 00 – Site Clearing.
- E. Section 31 20 00 – Earth Moving.
- F. Section 31 23 19 – Dewatering

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM A48, Gray Iron Castings, Spec. for.
 - 2. ASTM A276, Stainless and Heat-Resisting Steel Bars and Shapes, Spec. for.
 - 3. ASTM A 307 Carbon Steel Externally and Internally Threaded Fasteners.
 - 4. ASTM A615, Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, Spec. for.
 - 5. ASTM C361, Reinforced Concrete Low-Head Pressure Pipe, Spec. for.
 - 6. ASTM C443, Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, Spec. for.
 - 7. ASTM C478, Precast Reinforced Concrete Manhole Sections, Spec. for.
 - 8. ASTM C923, Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
 - 9. ASTM D 1784, Rigid Poly (Vinyl Chloride) Compounds and Chlorinated Poly (Vinyl Chloride) Compounds.

10. ASTM D 1785, Poly (Vinyl Chloride) (PVC) Plastic Pipe Schedules 40, 80 and 120.
 11. ASTM D2146, Propylene Plastic Molding and Extrusion Materials, Spec. for.
 12. ASTM D2240, Rubber Property-Durometer Hardness, Test Method for.
 13. ASTM D 2321, Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
 14. ASTM D 2467, Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 15. ASTM D 2564, Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
 16. ASTM D 3034, Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 17. ASTM D 3212, Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
 18. ASTM F 477, Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 19. ASTM F 789, Type PS-46 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings.
- B. American Water Works Association:
1. AWWA C 302, AWWA Standard for Reinforced Concrete Water Pipe-Noncylinder Type, Not Prestressed.
- C. Federal Specifications:
1. Fed. Spec. SS-S-210A, Sealing Compound, Preformed Plastic, for. Expansion Joints and Pipe Joints (Type 1 Rope Form).
- D. Commonwealth of Pennsylvania Department of Transportation (PADOT), Specifications Publication 408.

1.3 SUBMITTALS

- A. Shop Drawings and Product Data: Furnish completely dimensioned shop drawings, catalog cut or other data as required to provide a complete description of piping, fittings and other appurtenances specified herein.
- B. Certificates:
1. Certified records or reports of results of shop tests, such records or reports to contain a sworn statement that shop tests have been made as specified.
 2. Manufacturer's sworn certification that pipe will be manufactured in accordance with specified reference standards for each pipe type.
 3. Manufacturer's sworn certification that manhole frame and cover tensile test bars were poured from the same iron as castings they represent.
 4. Manufacturer's sworn certification that manholes were constructed using Type II Portland cement as specified in Source Quality Control.
 5. Manufacturer's sworn certification that manhole frame and cover meets or exceeds AASHTO HS-20 highway loading requirements.

1.4 QUALITY ASSURANCE

A. Design Criteria:

1. Use only one type and class of pipe in any continuous line of sewer between structures, unless otherwise indicated on the Drawings.
2. Use pipe and fittings designed to withstand imposed trench loading and conditions at the various locations.

B. Source Quality Control – Pipe and Fittings:

1. Shop Tests: The Architect reserves the right to require the manufacturer to perform such additional number of tests as the Architect may deem necessary to establish the quality of the material offered for use.
2. Laboratory Tests: The Architect reserves the right to require that laboratory tests also be conducted on materials that are shop tested. Furnish without compensation, labor, materials, and equipment necessary for collecting, packaging, and identifying representative samples of materials to be tested and the shipping of such samples to the Testing Laboratory.

C. Source Quality Control - Manholes:

1. Maintain uniform quality of products and component compatibility by using the products of one manufacturer in the case of precast reinforced concrete manholes.
2. Obtain certificate of construction compliance with ASTM C478 from the precast reinforced concrete manhole manufacturer.
3. Obtain sworn certification from manufacturer that manholes were constructed using Type II Portland cement.
4. Obtain certificate of material compliance with ASTM A48, Class 30 tensile strength from the manhole frame and cover manufacturer. Furnish certification that tensile test bars were from same pour as castings.
5. Obtain certification from manufacturer that manhole frame and cover meets or exceeds AASHTO HS-20 highway loading requirements.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Transport, handle and store pipe materials and other Products specified herein in a manner recommended by the respective manufacturers to prevent damage and defects.
- B. Transport and handle precast reinforced concrete manhole components and other Products specified herein in a manner recommended by the respective manufacturers of such to prevent damage and defects. Through-wall lifting holes not permitted in manhole component construction.
- C. Store precast reinforced concrete manhole components in accordance with manufacturer's recommendations to prevent joint damage and contamination. Exercise such care in storage of other specified Products as recommended by the respective manufacturers.

1.6 SITE CONDITIONS

A. Environmental Requirements:

1. Keep trenches dewatered until pipe joints have been made and concrete cradle and encasement, if any, have cured.
2. Under no circumstances lay pipe in water or on bedding containing frost.
3. Do not lay pipe when weather conditions are unsuitable, as determined by the Architect, for pipe laying work.
4. In no instance set or construct manhole bases on subgrade containing frost.

1.7 REGULATORY REQUIREMENTS

- A. The existing sewer system is privately owned by the school district. Connection to the existing sewer system and the installation of the sewer line extensions shall be coordinated with the district to ensure there are no outages or disruptions to the High School or other buildings served by the system.

1.9 TEMPORARY FACILITIES

- A. The Contractor shall be required to provide temporary sewer facilities to the existing stadium during the construction of the baseball field. The existing service lines need to be relocated and water service to the existing stadium must be maintained during

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Polyvinyl Chloride Pipe (PVC) - SDR 35:

1. Manufacturers:
 - a. J. M. Manufacturing Co.
 - b. Cresline Plastic Pipe.
 - c. Carlon
 - d. or equal
2. Pipe: Type PSM SDR-35, ASTM D 3034 (4"-15"), or Type PS-46, ASTM F 789 (4"-18").
3. Fittings: Conforming to same applicable ASTM Specification requirements for pipe.
4. Joints: ASTM D3212 push-on joint with ASTM F477 elastomeric gasket. Gasket shall be locked in groove of bell to prevent displacement when pipes are joined.

B. High Density Polyethylene (HDPE) - SDR 11:

1. Manufacturers:
 - a. J. M. Eagle
 - b. Certainteed

- c. or equal
- 2. Pipe: ANSI/AWWA C906, ASTM F714, ASTM D-3035, ASTM D-3350, PE4710, SDR-11, Class 200, NSF 14 and 61 certified.
- 3. Fittings: Conforming to same applicable ASTM Specification requirements for pipe.
- 4. Joints: Thermal Fused Joints for 4-inch through 2-inch pipe shall be jointed by thermal butt-fusion in accordance with ASTM D2657 and pipe manufacturer's recommendations. Termination to pump basins, valves, fittings, etc. made of other materials shall be flange assemblies. The pipe adjacent to these joints must be rigidly supported for a distance of one foot beyond flange assembly. Joints for 2-inch pipe shall be by socket fusion in accordance with ASTM D2657 and pipe manufacturer's recommendations.

C. Polyvinyl Chloride Pipe (PVC) - Schedule 40:

- 1. Not Used

2.2 PIPE SPECIALTIES

A. Steel Pipe Couplings:

- 1. Manufacturers
 - a. Dresser, Style 38
 - b. Smith-Blair, Style 411
 - c. Or equal.
- 2. Coupling shall consist of a middle ring, two (2) follower rings, two (2) gaskets and a sufficient number of bolts and nuts.
 - a. Middle Ring: ASTM A513 or ASTM A635 steel.
 - b. Followers: AISI C1012 or ASME SA 36.
 - c. Gasket: Resilient wedge-shaped suitable for use with raw sewage and sludge.
 - d. Bolts: AWWA C111/ANSI A21.11.
- 3. Use transition gaskets designed for making transition to pipe of differing materials.

2.3 BASIC MANHOLE MATERIALS

- A. Cast-In-Place Concrete Products: Form work, Reinforcement, and Cast-In-Place Concrete conforming to requirements of PADOT Publication 408, Section 704, Type AA 3,500 psi compressive strength at 28 days) except Type II Portland cement shall be used.

B. Epoxy Bonding Compound:

- 1. Manufacturers:
 - a. A. C. Horn EPOXTITE BINDER
 - b. Sika Chemical SIKADUR-HI-MOD
 - c. or equal
- 2. Multi-purpose, high-modulus, high-strength, 2-component, solvent free, moisture insensitive, epoxy bonding/grouting adhesive.

C. Non-Shrink Non-Metallic Grout

1. Manufacturers
 - a. Master Builders, Inc., Masterflow 928
 - b. U.S Grout Corporation, Five Star Products
 - c. or equal
2. Ready Mix, ASTM C1107 high precision, natural aggregate grout.

D. Manhole Steps: Locate as shown on Drawings.

1. Aluminum Step: Aluminum Alloy AA Designation 6061-T6, 3/4-inch minimum diameter and 12-inches minimum rung width with drop front to prevent side slipping. Coat that portion of aluminum step being embedded in concrete with heavy-bodied bituminous paint. Aluminum manhole steps No. 12653B by ALCOA or equal.
2. Reinforced Plastic Step: Composed of a 1/2-inch Grade 60, ASTM A615 deformed steel reinforcing bar completely encapsulated in Grade 49108, ASTM D2146 polypropylene copolymer compound, Type II; M. A. Industries, Inc., Type PS2-PF or PS2-PFS; or equal.
3. Manhole step dimensions shall meet requirements of OSHA Standard 1910.27 for fixed ladders.

E. Watertight Manhole Frame and Cover:

1. Manufacturers:
 - a. Quirin
 - b. Neenah Foundry Company
 - c. Modena Foundry
 - d. Or equal.
2. General: Gray iron castings conforming to ASTM A48, Class No. 30, designed for AASHTO Highway Loading Class HS-20 with four (4) hold-down bolts. Provide castings of uniform quality, free from blowholes, porosity, hard spots, shrinkage distortion or other defects.
 - a. Finish: Bearing surfaces machined to prevent rocking and rattling under traffic. Casting surfaces shotblast cleaned and coated with asphalt paint, non-tacky drying.
 - b. Identification: Cast the letters "SEWER" integrally in center of cover in 2-inch raised letters.
 - c. Frame Hold-down Bolts: Type 316 stainless steel, ASTM A276 bolts and washers.
 - d. Cover Hold-down Bolts: 3/4- inch diameter minimum type 316 stainless steel, ASTM A276 bolts and washers; or manufacturer's standard bronze bolts and washers. Drill and tap frame to accept cover hold down bolts.
 - e. Threaded Sleeves: Manhole frame factory fitted with stainless steel or bronze threaded sleeve to accept cover bolts.
 - f. Cover Gasket: One piece O-ring gasket factory installed in a machined rectangular or dovetail groove in the cover-bearing surface.
 - i. Gasket material of neoprene composition having good abrasion resistance,

low compression set, Type D 40 durometer hardness determined in accordance with ASTM D 2240 and suited for use in sanitary sewer manholes.

ii. Gluing of gasket is not permitted.

g. Tensile Test Bar: Size B, cast separately, but poured from same iron as castings they represent.

F. Preformed Plastic Sealing Compound:

1. Manufactures:

- a. K. T. Snyder Company, Inc.; RAM-NEK.
- b. K. T. Snyder Company, Inc.; RUB'R-NEK.
- c. Hamilton Kent Manufacturing Company; KENT-SEAL NO. 2.
- d. Or Equal.

2. Fed. Spec. SS-S-210A, Type 1, Rope Form, of either bitumastic base compound or butyl rubber base compound, and shipped protected in a removable two-piece wrapper. Size cross-section of rope form to provide squeeze-out of material around entire interior and exterior circumference when joint is completed.

G. Rubber Compression Gasket: Composition conforming to ASTM C 361 or ASTM C 443.

H. Expandable Sleeve Type Pipe Opening Seal: ASTM C923, consisting of a power sleeve, gasket and two (2) take up clamps. Sleeve is mechanically expanded to compress gasket against receptacle hole in manhole wall. Provide seal equivalent to Press Seal Gasket Corp. PSX Positive Seal Gasketing System.

- 1. Power Sleeve: Type 304 stainless steel, 85,000 psi yield strength.
- 2. Gasket: Compound Polyisoprene suitable for use with raw sewage.
- 3. Take Up Clamps: Type 304 stainless steel with stainless steel screw.

I. Modular Mechanical Type Pipe Opening Seal: Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with stainless steel bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the pipe and the wall opening. The seal shall be constructed so as to provide electric insulation between the pipe and wall to reduce the occurrence of cathodic reaction between the two members. Wall penetration closures shall be "Link-Seal" as manufactured by Thunderline Corp., or equal.

J. Manhole Adapters: Gasket type waterstop composed of elastomeric polyvinyl chloride (PVC) such as manufactured by Fernco Joint Sealer Co.; CMA Concrete Manhole Adapter. (CMA Waterstop distributed by The General Architecting Company, Frederick, Maryland)

K. Coatings:

1. Manufacturers

- a. Koppers 300 M Coal Tar Epoxy
 - b. Or equal.
2. Apply two (2) coats to outer surface of entire manhole to waterproof manhole.

2.4 PRECAST REINFORCED CONCRETE MANHOLE COMPONENTS

- A. Materials and Construction: Conforming to requirements specified in ASTM C478 except as follows:
 1. Concrete: Composition and compressive strength conforming to ASTM C478 except use Type II sulfate resistant or Type III high early strength Portland cement in manhole components and increase compressive strength to 4500 psi (at 28 days) in precast bases.
 2. Casting and Curing: Wet cast and steam curing process in accordance with Section 3.6.11 and 3.7.2 of AWWA C302.
 3. Manhole Steps: Factory installed in manhole components, prealigned vertically, spaced on equal centers, and located the minimum distance from ends of risers and top sections as indicated on Standard Detail Drawings. Materials as previously specified.
 4. Manhole Component Seals: Manhole component joints factory formed for self-centering concrete to concrete bearing employing either a Rubber Compression Gasket or Preformed Plastic Sealing Compound. Materials as previously specified.
 5. Manhole Component Design: Base, tapered and straight riser section, and top section dimensions and diameters, not consistent with ASTM C 478, are as indicated on Drawings.
 6. Lifting Holes and Lugs: Thru-wall holes shall not be permitted in manhole component construction.
 7. PennDOT Compliance: In addition to above specifications, manholes for installation within PennDOT rights-of-way shall also conform to PennDOT Publication 408 specifications.
- B. Precast Bases and Riser Sections: Design, materials and construction as specified previously.
- C. Pipe Openings: Custom preformed during manufacturing in each base and riser section requiring such, to accommodate type of pipe and pipe opening seal provided.
- D. Pipe Opening Seals: Option to install one of the following:
 1. Resilient Gasket Type Pipe Opening Seal:
 - a. Manufacturers:
 - i. A Lok Products Corporation; A LOK Manhole Pipe Seal.
 - ii. Scales Manufacturing Corporation; RES-SEAL.
 - iii. Press Seal Gasket Corporation; PRES-WEDGE II.
 - iv. Thunderline Corporation; LINK-SEAL Modular Wall and Casing Seal.
 - v. Dual Seal Gaskets Inc.; DUAL SEAL II.
 - b. Cast integrally with manhole component conforming to requirements specified in ASTM C 923.
 2. Expandable Sleeve Type Pipe Opening Seal: As previously specified herein this Section.

E. Precast Top Sections: Designs as shown on Standard Detail Drawings of materials as specified previously herein this Section except additional and differing requirements as follows:

1. Hold Down Bolt Inserts: Factory cast in top section no less than two 3/4-inch diameter threaded inserts or slotted inserts to accommodate manhole frame hold down bolts. Threaded inserts of 3-inches depth. Both insert types designed for an ultimate load in tension of 12,500 pounds. Inserts factory plugged for shipping. Coordinate insert location with manhole component manufacturer to assure proper location in top sections.
2. Flat Slab Tops: Thickness versus diameter as indicated on Drawings. Tops factory formed to properly accept and support required manhole frame and cover and formed to join riser section in a matching joint.
3. Eccentric Cone Tops: Manufactured to same minimum wall thickness and with same area of circumferential steel reinforcement as riser sections.

F. Precast Grade Rings: Leveling and adjusting units of 3-inches or 4-inches thickness of materials and constructions as specified previously. Factory cast grade rings with hold down bolt holes matching location of same in manhole frame. Design must provide for full bearing of manhole frame.

2.5 SEWAGE GRINDER PUMPS

- A. Provide sewage grinder pumps in accordance with those specified on the Drawings.
- B. Or equal grinder pumps must meet the specification on the Drawings for pump configuration, horsepower and voltage. Pumps must be compatible with building electrical systems.
- C. Provide air release valves in accordance with those specified on the Drawings. Air release valves shall be installed where specified on the plans. The Work shall include the complete assembly with tapping saddle, shutoff valve, air release and vacuum valve, piping and fittings, all complete and ready for operation. The valve shall function automatically to release into the atmosphere both large and small amounts of air that accumulate in the pipeline. The valve shall also function to admit air into the pipeline under emergency conditions or when it is being drained. The valve shall be of a type having a stainless-steel float enclosed in the valve body with a lever for opening and closing the valve. The assembly shall not leak, nor the valve stick under service conditions. The valves shall be as manufactured by Val-Matic, APCO, GA Industries, or approved equivalent.
- D. The CONTRACTOR shall furnish the valve with shutoff valve, blowoff valve, quick disconnect couplings, and a minimum of 5 feet of hose to permit back-flushing after installation without dismantling the valve.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Carefully examine each section of pipe and each pipe fitting before laying in conformance with the inspection requirements of the appropriate referenced standard.
- B. Remove rejected pipe from the site.
- C. Inspect precast reinforced concrete manhole components in accordance with requirements of ASTM C 478 regarding repairable defects and defects subject to rejection by the Architect.
- D. All material found during the progress of the work, either before or after installation, to have cracks, flaws or other defects will be rejected by the Architect. All defective materials shall be replaced and promptly removed from the site.

3.2 PREPARATION

- A. Clean piping interior and mating surfaces of bell, spigot and gasket before laying. Maintain clean until completed work is accepted.
- B. Touch-up chipped, cracked, or abraded surfaces and finished joints with two coats of the particular coating material.
- C. Perform trenching for sewer pipe and place pipe bedding as specified in Section 312000 - Earthwork.
- D. Dig bell holes sufficiently large to permit proper joint making and to insure pipe is firmly bedded full length of its barrel.
- E. Excavate trenches in rock at least twenty-five (25) feet in advance of pipe laying. Protect pipe ends if blasting is allowed.

3.3 LAYING PIPE

- A. General Requirements:
 - 1. Lay pipe proceeding upgrade true to line and grades given. Lay bell and spigot pipe with bell end upgrade unless shown otherwise on the Drawings or directed by the Architect.
 - 2. Exercise care to ensure that each length abuts against the next in such manner that no shoulder or unevenness of any kind occurs along inside bottom half of pipeline.
 - 3. Center spigot end in bell or socket end of previously laid pipe, shove tight and secure.
 - 4. No wedging or blocking permitted in laying pipe unless by written order of Architect.
 - 5. Before joints are made, bed each section of pipe full length of barrel with recesses excavated so pipe invert forms continuous grade with invert of pipe previously laid. Do not bring succeeding pipe into position until the preceding length is embedded and securely in place.
 - 6. Walking or working on completed pipeline, except as necessary in tamping and backfilling, not permitted until trench is backfilled one-foot deep over top of pipes.
 - 7. Take up and relay pipe that is out of alignment or grade, or pipe having disturbed joints

after laying.

8. Take up and replace with new, such in-place pipe sections found to be defective.
9. Take necessary precautions to prevent newly laid pipe from floating as a result water accumulation in the trench; or the collapse of the pipeline from any cause. Restore or replace pipe when damaged.
10. Bed pipe and place initial backfill over pipe using materials specified as scheduled on the Drawings.
11. At the close of each day's work, and at such other times when pipe is not being laid, protect open end of pipe with a close-fitting stopper.
12. Cut pipe using only equipment specifically designed for that purpose such as an abrasive wheel, rotary wheel cutter, a guillotine pipe saw or a milling wheel saw. The use of chisels or handsaws will not be permitted. Grind smooth cut ends and rough edges. Bevel slightly, cut end for push-on connections.
13. Where cutting of pipe is necessary, minimum laying length shall be five (5) feet.

B. Specific Requirements:

1. Install plastic pipe and fittings, and assemble joints according to ASTM D 2321 for Class 1 bedding material.

C. Joints:

1. Make pipe and fitting joints according to pipe manufacturer's specifications and to specifications previously specified for pipe.
2. Make joints watertight. Immediately repair detected leaks and defects. Methods of repair subject to Architect's approval.

D. Alignment and Grade:

1. Lay and maintain all pipe at the required lines and grades as shown on the Drawings. Place fittings and valves at the required locations with joints centered, spigots forced home, and all valve stems plumb. Do not deviate from the required line and grade, except with the approval of the Architect.
2. Deflect pipe joints where indicated on the Drawings. Deflections shall not exceed $\frac{1}{2}$ of pipe manufacturer's recommended maximum allowable deflection.
3. Do not change grade or alignment without Architect's approval.

3.4 FLUSHING OF LINES

- A. Prior to commencing any line testing, thoroughly flush all newly installed lines to remove dirt, rocks and other construction debris that may be present. Provide means to collect debris prior to connection to the existing public sewer system and dispose of in a lawful manner. Under no circumstances shall the dirt, rocks and other construction debris be flushed into the public sewer system.

3.5 MANHOLE INSTALLATION

- A. Cast-In-Place Concrete Manhole Base: Construct in accordance with design and dimensions indicated on Drawings. When necessary to construct wider or deeper manhole bases than indicated or specified, build such bases as required by the Architect.
1. Form and pour concrete following PADOT Publication 408 specifications. Additional requirements as follows:
 - a. Vibrate poured concrete using mechanical vibrator of a type and design approved by Architect. Use vibrators of type capable of transmitting vibration to concrete in frequencies of not less than five thousand impulses per minute.
 - b. Form and pour joint monolithically in manhole base top to match joint of adjoining precast riser section. Use template as obtained from precast concrete manhole component manufacturer of manhole components used in the Project.
 2. Install sewer piping in cast-in-place manhole bases prior to pouring the concrete.
 - a. Apply Epoxy Bonding Compound in accordance with manufacturers instructions to pipe at base connection prior to pouring the concrete.
 - b. Install Manhole Adapter on pipes entering and leaving manhole base prior to pouring concrete. Install Manhole Adapter according to manufacturer's written instructions.
- B. Precast Concrete Bases:
1. Install precast bases on aggregate subbase. Materials and thickness as shown on the Standard Details.
 2. When pipe opening seal materials create an annular space on interior and exterior of manhole wall pipe openings after pipe connection is made, fill such annular spaces with preformed plastic sealing compound.
 - a. Tightly caulk sealing compound into annular spaces in a manner to completely fill the spaces and render the installation watertight.
 - b. Following sealing compound installation, trowel compound surface smooth and flush with interior face of manhole.
- C. Length of Pipe Connections into Manholes:
1. Use pipes no longer than 5-feet in length when connecting into manholes through resilient gasket type pipe opening seals.
 2. For all other pipe connections into manholes, use pipes of such length that a pipe joint is provided at the outside edge of manhole base or wall as applicable. Also use pipes no longer than 6 feet in length for first pipe joined thereto.
- D. Concrete Channel Fill: Field pour concrete channel fill for each manhole base.
1. Form inverts directly in concrete channel fill.
 2. Accurately shape invert to a semi-circular bottom conforming to inside of connecting pipes, and steel trowel finish to a smooth dense surface.
 3. Make changes in size and grade gradually.

4. Make changes in direction of entering sewer and branches to a true curve of as large a radius as manhole size will permit.
 5. Make slopes gradual outside the invert channels.
 6. Use 3000 psi Type II concrete unless indicated otherwise on Drawings.
- E. Manhole Wall Erection: Provide precast reinforced concrete straight riser, tapered riser and top sections necessary to construct complete manholes. Fit the different manhole components together to permit watertight jointing and true vertical alignment of manhole steps.
1. Install sealing compound in accordance with manufacturer's recommendations, and join sections also in accordance with written instructions of manhole component manufacturer.
 - a. Prime joint surfaces if required by preformed sealing compound manufacturer.
 - b. If sealing compound is installed in advance of section joining leave exposed half of two piece protective wrapper in place until just prior to section joining.
 - c. Use preformed sealing compound as the sole element utilized in sealing section joints from internal and external hydrostatic pressure.
 - d. To improve workability of "Preformed Plastic Sealing Compound" during cold weather, store such at temperature above 70 degrees F or artificially warm compound in a manner satisfactory to the Architect.
 - e. During warm weather stiffen "Preformed Plastic Sealing Compound" by placing under cold water or by other means as recommended by the compound manufacturer.
 - f. Following manhole section installation, trowel sealing compound surface smooth and flush with interior face of manhole.
 - g. Make pipe connections into manhole walls as specified previously for pipes connecting into manhole bases.
- F. Lifting Recess Sealing: Seal with properly designed tapered rubber plugs. Drive plugs into recesses in such manner to render them completely water and air tight. Sealing of lifting recesses with grout not permitted.
- G. Frame and Cover Installation: Where required, make final adjustment of frame to elevation using Precast Grade Rings.
1. Set Precast Grade Rings in Non-shrink Non-metallic Grout. Grout thickness shall not exceed 3/4-inch maximum and 3/8-inch minimum. Wet, but do not saturate Precast Grade Rings immediately before laying.
 2. Parge the inside and outside of the grade rings to a minimum thickness of 1/2 inch using Non-shrink Non-metallic Grout.
 3. Bolt manhole frames only following grout curing period. Install manhole frames on 1/2-inch thick Preformed Plastic Sealing Compound on bearing surface of manhole frame. Remove excess sealing compound as it is squeezed out after manhole frame is bolted in place.
 4. Use bolts of sufficient length to properly pass through leveling units, if any, engage full depth of manhole top section inserts and allowing enough threaded end to pass through

manhole frame to properly tighten nut and washer. Tighten manhole frame bolts after grout has cured.

- H. Waterproofing: Coat entire outer surface of all manhole components including parged grade rings with two (2) coats of a Bitumastic Coating.
- I. Drop Manholes: Construct in accordance with type indicated in Standard Detail. Use same type pipe and fittings in drop connection as used in sewer line from which drop connection is made.
- J. Plugging Pipe Openings: Plug pipe openings in manholes where such openings are required for future pipe connections. Use manufactured units specifically designed for the purpose. Plugs shall be designed to allow for future removal without damage to manhole.

3.6 PIPE CONNECTIONS TO EXISTING MANHOLES

- A. Make connection to existing manhole by core drilling pipe opening in wall at invert elevation to match existing.
- B. Remove existing bench as needed to make new connection. Reconstruct bench and form new flow channel after new pipe has been inserted.
- C. Seal pipe to wall opening using either the Expandable Sleeve Type or Modular Mechanical Type Pipe Opening Seal previously specified.

3.7 SEWAGE GRINDER PUMPS INSTALLATION

- A. Contractor shall coordinate with the Plumbing Contractor to confirm invert elevation of the building sewer prior to installation.
- B. Contractor shall coordinate with Electrical Contractor regarding power supply to the pump and mounting of alarm equipment on building.
- C. Contractor shall install grinder pumps in the locations indicated on the plans and in accordance with Drawings and manufacturer's installation requirements.
- D. Installed grinder pumps shall be protected from construction traffic.

3.8 FIELD QUALITY CONTROL - PIPE

- A. General Requirements: Conduct tests specified herein so that each pipe line installed in the Project is tested to the Architect's satisfaction.
 - 1. Provide tools, materials, including water, apparatus and instruments necessary for pipe line testing.

2. Conduct tests in the presence of and to the satisfaction of the Architect.
- B. Alignment: After the mains have been laid and backfilled, a light will be flashed between manholes or manhole locations to determine whether the alignment of the sewer is true and whether any pipe has been displaced, broken or otherwise damaged subsequent to laying. This test will again be conducted before final acceptance of the sewer. Each section (manhole to manhole) of sewer shall show a good light circle throughout its length and any and all defects shall be corrected.
- C. Leakage Tests:
1. Air Testing: Test each section of sewer between manholes and all laterals to the limit of this contract using low-pressure air. Testing shall not be performed, until all backfilling has been completed. The Contractor may, at his option, test the section of sewer for his own purposes, prior to completion of backfilling; however, the requirements of this subsection shall not be deemed to be completed until the lines have been tested after the backfilling has been completed and trench settlement has been minimized.
 2. A minimum of two minutes shall be provided to allow equilibrium of the air temperature with pipe wall before test readings shall commence. The rate of air loss shall be determined by measuring the time interval required for the average internal pressure to decrease by 1.0 psig.
 3. The initial test pressure to be developed in the sewer and laterals shall be determined as follows:
 - a. For depths six (6) feet or less, the internal pressure shall not be less than 6.0 psig.
 - b. For depths greater than six (6) feet, the internal pressure in psig shall be calculated as the sum of 3.5 plus the maximum height in feet divided by 2.3 between the invert of the sewer and the existing ground surface in the section of sewer to be tested. (For example, if the maximum height is determined to be 9.2 feet, the added pressure would be 4.0 psig. The initial test pressure in the sewer would then be 7.5 psig.
 - c. In no case shall the test pressure in the sewers or laterals be greater than the maximum internal differential joint pressure recommended by the manufacturer of the pipe.
 4. Time of test shall be 5 minutes minimum. No pressure loss shall be permitted over time of test for pipe to be considered acceptable.
 5. If any leakage is detected, determine source of leakage and make all necessary corrections and retest.
 6. Submit to the Architect for approval the detailed test procedure and list of test equipment he proposes to use prior to testing.
 - a. After the air testing described in the preceding paragraph has been completed, regardless of any indications of the test results made by the Architect or the Owner, the Architect and the Owner reserve the right to perform field investigations, prior to final written acceptance of each sewer run by the Owner and/or during the maintenance period specified elsewhere in these Specifications, to establish the leakage of groundwater into the sewer and laterals constructed under this contract.
 - b. Should the leakage exceed 100 gallons per day per inch diameter per mile of pipe

for any section, perform additional testing or corrective work required to reduce the infiltration in each manhole run from those lines installed as part of the Work to less than 100 gallons per day per inch diameter per mile of pipe. This leakage applies to each manhole run separately and should not be construed to mean total leakage in the total system. The scope of this corrective work shall include, but not be limited to, cleaning, televising and testing the sewer and laterals to the limits installed as part of the Work, to include testing and grouting of joints, excavation and replacement of faulty or damaged portions of the work, and all final restoration.

3.9 FIELD QUALITY CONTROL - MANHOLES

- A. General: Test each manhole constructed as part of the Work by one of the specified methods. If the manhole is constructed on an existing sewer where sewage flow must be maintained, the test will be waived.
 - 1. Conduct tests in presence of and to complete satisfaction of the Architect.
 - 2. Should a manhole not satisfactorily pass testing, discontinue manhole construction in the Project until such manhole does test satisfactorily.
 - 3. Provide tools, materials (including water), equipment and instruments necessary to conduct manhole testing specified herein.
 - 4. Prior to testing manholes, thoroughly clean such and seal openings, both to complete satisfaction of the Architect. Seal openings using properly sized plugs.
 - 5. Perform testing with frames installed. The joint between the manhole and the manhole frame shall be included in the test.
 - 6. The Contractor may elect to make a test prior to backfilling for his own purposes; however, the tests of the manholes for acceptance, shall be conducted after the backfilling has been completed.
- B. Vacuum Testing
 - 1. Vacuum Testing Equipment:
 - a. Use vacuum apparatus equipped with necessary piping, control valves and gauges to control air removal rate from manhole and to monitor vacuum.
 - b. Provide an extra vacuum gauge of known accuracy to frequently check test equipment and apparatus.
 - c. Vacuum testing equipment and associated testing apparatus subject to Architect's approval.
 - d. Provide seal plate with vacuum piping connections for inserting in manhole frame.
 - 2. Vacuum Test Procedure:
 - a. Perform vacuum testing in accordance with the testing equipment manufacturer's written instructions.
 - b. Draw a vacuum of (-) ten-inches of mercury and close the valves.
 - c. Consider manhole acceptable when vacuum does not drop below (-) nine-inches of mercury for the following manhole sizes and times.
 - i. Four foot diameter - 60 seconds

- ii. Five foot diameter - 75 seconds
- iii. Six foot diameter - 90 seconds

C. Exfiltration Test Procedure:

- 1. Completely fill manhole with water.
- 2. Allow water filled manhole to stand twelve hours prior to testing to allow absorbing in materials.
- 3. At commencement of test, fill manhole to top of manhole frame.
- 4. During a consecutive four-hour period keep an accurate record of the amount of water to be added because of exfiltration.
- 5. Consider manhole acceptable when exfiltration rate does not exceed a rate of 0.0189 gallons a day per inch of manhole diameter per vertical foot of manhole.

D. Repair and Retest: Determine source or sources of leaks in manholes failing acceptable limits.

- 1. Repair or replace defective materials and workmanship, as is the case, and conduct such additional Manhole Acceptance Tests and such subsequent repairs and retesting as required until manholes meet test requirements.
- 2. Materials and methods used to make manhole repairs must meet with Architect's approval prior to use.
- 3. Make repairs, replacements and retests at no additional expense to Owner.

3.10 PIPING SCHEDULE

- A. Construct sewer lines using the materials noted on the Drawings.

END OF SECTION

SECTION 33 40 00 – STORM DRAINAGE UTILITY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Drain culverts and storm drainage pipes.
- B. Site storm drainage construction, inlets, catch basins, manholes, grates, frames, covers, drainage pipe and fittings.
- C. Underground storm water detention beds.
- D. Infiltration Basins

1.2 RELATED SECTIONS

- A. Division 1 – General Requirements
- B. Division 3 – Concrete
- C. Section 31 00 05 – Basic Methods and Materials
- D. Section 31 20 00 – Earth Moving: Excavating, trenching for storm sewer structures and basins; construction of surface drainage swales and geosynthetic linings.

1.3 RELATED DOCUMENTS

- A. Erosion and Sediment Control Plan and Narrative: Sequence installation of storm sewers, inlet protection, and temporary control measures in accordance with the project phasing.

1.4 REFERENCES

- A. Pennsylvania Department of Transportation (PennDOT) Specifications Publication, Form 408, Section 714 – Precast Manholes
- B. Pennsylvania Department of Transportation (PennDOT) Specifications Publication, Form 408, Section 605 – Endwalls, Inlets, and Manholes
- C. Pennsylvania Department of Transportation (PennDOT) Specifications Publication, Form 408, Section 601 – Pipe Culverts
- D. Pennsylvania Department of Transportation (PennDOT) Specifications Publication, Form 408, Section 851 – Rock Energy Dissipater

- E. Pennsylvania Department of Transportation (PennDOT) Specifications Publication, Form 408.
 - F. Pennsylvania Department of Transportation (PennDOT) Standards for Roadway Construction, RC 30 – Subsurface Drains, Publication 72.
 - G. Pennsylvania Department of Transportation (PennDOT) Standards for Roadway Construction, RC 31 – Endwalls, Publication 72.
 - H. Pennsylvania Department of Transportation (PennDOT) Standards for Roadway Construction, RC 34 – Inlets, Inlet Assemblies, Publication 72.
 - I. Pennsylvania Department of Transportation (PennDOT) Standards for Roadway Construction, RC 39 – Standard Manholes, Publication 72.
 - J. Pennsylvania Department of Transportation (PennDOT) Standards for Roadway Construction, RC 0-100, Publication 72.
 - K. ASTM C478-Precast Reinforced Concrete Manhole Sections
 - L. ASTM F667, Standard Specifications for Large Diameter Corrugated Polyethylene Pipe and Fittings.
 - M. AASHTO M294, Standard Specifications for Corrugated Polyethylene Pipe, 12” to 36” diameter.
 - N. ASTM F477, Specification for Elastomeric Seals (Gaskets for Joining Plastic Pipe).
 - O. ASTM D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
 - P. ASTM D3212, Specification for Joint Performance
 - Q. ASTM C76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
 - R. ASTM C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
 - S. ASTM D3034, SDR 35 Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings, size 4” through 15”.
 - T. ASTM D2564 – Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
 - U. ASTM D2855 – Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
- 1.5 SUBMITTALS

- A. Submittal procedure as specified in Division 1.

- B. Shop Drawings for Review:
 - 1. Submit shop drawing for all drainage structures.
- C. Product Data: Submit product data and material specifications for drainage pipe and storm drainage structures. Provide source or supplier from which products will be obtained.
- D. Manufacturer's Specifications: Submit manufacturer's specifications and guidelines for installation of storm drainage pipe and structures.
 - 1. Manufacturer's Certification: Submit manufacturer's certification that storm drainage products meet or exceed referenced standards.

1.6 CLOSEOUT SUBMITTALS

- A. Division 1 – General Requirements.
- B. Project Record Documents:
 - 1. Accurately record actual locations of pipe runs, connections, junctions, inlets, yard drains, area drains, manholes, clean outs, top of grate elevations, rim elevations, and invert elevations.
 - 2. Record Survey: Prepare record topographic survey of storm water detention basins as specified in Section 312000.
 - 3. Photographic Documentation: It is required that the Contractor document the installation of all underground utilities and structures prior to and during the backfill process.

1.7 COMPLIANCE WITH AUTHORITIES HAVING JURISDICTION

- A. Local Municipal Improvement Standards and Permits: Contact the local municipality having jurisdiction and obtain any Improvement Specifications, standards, and permits required for storm drainage construction.
 - 1. Obtain construction permits that may be required by the municipality having jurisdiction.
 - 2. Perform all Work in municipal roadway and utility rights-of-way or easements in accordance with any applicable municipal standards and regulations. Notify the municipal agency having jurisdiction prior to performing any Work subject to municipal jurisdiction and arranging inspections when required by local municipal representatives. The District shall be responsible for all fees incurred as part of the municipal inspections.
- B. Erosion and Sediment Control Plan and Narrative: All Prime Contractor's performing excavation will follow DEP Chapter 102 regulations during construction and be responsible for correcting any violations cited by the local Conservation District. Contractor will install controls as described and detailed on the approved plan and narrative. Approved plan and narrative

sequences earthwork, installation of storm sewers, inlet protection and temporary control measures as part of storm drainage installation.

1.8 COORDINATION

- A. Coordinate the Work to prevent unauthorized drainage on to adjacent properties, prevent unnecessary disturbance or accelerated erosion, accommodate project scheduling and phasing, and comply with the erosion control Permit
- B. Verify location of existing utilities and location and condition of existing storm sewers and structures that will be connected to as part of the Work. Notify District when conflicts are found to exist or existing structures are unsuitable for connection.

1.9 VERIFICATION

- A. Verify location of existing utilities and notify District where conflicts are found to exist with storm drainage Work. District shall modify storm drainage alignment, elevations, or location to avoid conflict where possible. Where the conflict cannot be avoided, relocate existing utility, or provide concrete encasement upon approval by the District for any additional cost.
- B. Verify location, invert, and condition of existing storm sewers or storm drainage structures required for connection with the storm drainage Work. Notify District where conflicts are found to exist or existing structures or drainage pipe are unsuitable for connection.

PART 2 - PRODUCTS

2.1 STORM DRAINAGE PIPE

- A. Storm Drainage Pipe: Storm drainage pipe material and inside diameter of pipe is designated on Drawings.
 - 1. CPP: Corrugated polyethylene pipe, diameter as identified on Drawings.
 - 2. SLCPP: Smooth-lined corrugated polyethylene pipe, diameter as indicated on Drawings.
 - 3. RCP: Reinforced concrete pipe, diameter as indicated on Drawings.
 - 4. CMP: Corrugated metal pipe, diameter as indicated on Drawings.
 - 5. SRCMP: Spiral rib corrugated metal pipe, diameter as indicated on Drawings.
 - 6. PVC: Polyvinyl chloride pipe, diameter as indicated on Drawings.
- B. Corrugated Polyethylene Pipe and Fittings - CPP
 - 1. Not Used.
- C. Smooth-Lined Corrugated Polyethylene Pipe and Fittings – SLCPP

1. Circular pipe having a smooth interior and annular corrugated exterior meeting the requirements of AASHTO M252, Type S for pipe diameters 4-inch to 10-inch and AASHTO M294, Type S, for pipe diameters 12-inch to 36-inch. Pipe material shall be high density polyethylene, HDPE, meeting the requirements of ASTM-D1248, Type III, Class C, Category 4, Grade P33.
 2. Integral bell and spigot type joint meeting the requirements of AASHTO M294 with integral gasket. Gaskets shall be manufactured from elastomeric material providing silt-tight performance meeting the requirements of AASHTO M294 for soil tightness. Manufacturer shall specify that joint demonstrates soil tightness as measured by its ability to pass a 2-psi hydrostatic test without leakage.
 3. Manufacturer's:
 - a. Hancor, High-Q Drainage Pipe and Fittings (1-800-537-9520).
 - b. Advanced Drainage Systems, N-12 Drainage Pipe and Fittings (1-800-733-9554).
 - c. Lane Enterprises, HDPE Pipe with .012 manning N, (1-866-864-7419)
 - d. Substitutions: Section 01 60 00 – Product Requirements.
- D. Reinforced Concrete Pipe – RCP
1. Circular concrete pipe meeting the requirements of ASTM C76, Class IV, with rubber compression gaskets meeting the requirements of ASTM C433.
 2. Publication 280. Provide RC pipe conforming to BD-636M, PennDOT Design Manual Part 4M, Appendix H, and the Pennsylvania Installation Direct Design (PAIDD) computer program. Manufacture and test according to Publication 280.
- E. Corrugated Metal Pipe and Fittings – CMP
1. All corrugated metal pipe and fittings must be in accordance with PennDOT form 408 specifications
 2. Corrugated Steel Pipe, Metallic Coated. AASHTO M 36, Types I and IR; AASHTO M 218; AASHTO M 274; and AASHTO M 289
 3. Corrugated Aluminum Alloy Pipe. AASHTO M 196, Types I and IR
 4. Coated Corrugated Galvanized Steel Pipe. AASHTO M 245, Type I; AASHTO M 246; and AASHTO M 218. Fabricate pipes with coatings as follows:
 - a. Grade 10/10 — 10 mil coating on all surfaces.
- F. Flat Panel Turf Field Underdrain: Two-part, pre-fabricated system consists of a 1" thick x 12" wide solid formed polystyrene perforated core that is fully wrapped with a non-woven spun-bound polypropylene filter fabric in accordance with ASTM D7001-20.
1. Provide a 1" x 12" underdrain system fabricated from high-density polyethylene pipes and surrounded by a synthetic geotextile.
 2. Performance Criteria:
 1. Core:
 - a. Thickness: 1.0 in., ASTM D-1777
 - b. Flow Rate: 30 gpm per ft., ASTM D-4716

- c. Pipe Stiffness: 100 psi, ASTM D-2412
- d. Compressive Strength: 6000 psf, ASTM D-1621, Sand Method

2. Geotextile:

- a. Weight: 4.0 oz. per sq. yd.², ASTM D-3776
- b. Tensile Strength: 100 lbs., ASTM D-4632
- c. Coefficient of Perm: 0.2 cm. per sec., ASTM D-4491
- d. Flow Rate: 140 gpm per ft.², ASTM D-4491
- e. Apparent Opening Size: 70 maximum US standard sieve opening, ASTM D-4751
- f. UV Stability: 70% strength retained at 500 hours, ASTM D-4355
- g. Seam Strength: 150 lbs. per ft., ASTM D-4595
- h. Fungus: No Growth, ASTM G-21

3. Acceptable Products/Manufacturers:

- a. SportsEdge, HQ Panel Drain, (800) 334-6057, www.sportsedge.com
- b. JDR ENTERPRISES, INC., J-Drain SWD-12, (800) 843-7951, www.j-drain.com
- c. Advanced Drainage Systems, AdvanEdge, (1-800-733-9554).

4. Fittings and Pipe:

- 1. Fittings used with the drain shall be as recommended by manufacturer for drainage product.
- 2. The 1" x 12" flat drains shall connect to perimeter tile drain with pre-manufactured or approved fittings. Provide all necessary connectors and waterproof tape for a proper and secure connection to the collectors.
- 3. Attach flat drains to fabric every 15 feet with suitable duct tape on nails as required to prevent movement of drains during installation of stone aggregate base course.

G. Polyvinyl Chloride Pipe and Fittings – PVC

- 1. SDR-35, ASTM 3034 PVC piping and fittings.

2.2 STORM DRAINAGE PIPE FITTINGS

- A. Provide fittings of the same material as pipe when connecting pipes of common material as supplied by the pipe manufacturer or fittings produced by other manufacturers that are compatible with the drainage pipe material being used. Fittings shall not reduce or impair the overall integrity of the pipe.
- B. Provide flexible-type mechanical couplings, Fernco or equal, or standard manufacturers adapter couplings when joining pipes or fittings of different material.
- C. Joint performance of fittings shall meet or exceed the joint performance required for the drainage pipe as specified in Section 2.3.

- D. Provide standard tees, wyes, elbows, and bends where required to change horizontal alignment, fabricate vertical risers, or clean-outs.
- E. Provide standard fabricated fittings, couplers, reducers, tapping tees, saddling tees, or reducing tees when connecting pipes without a storm drainage structure such as an inlet, yard drain, drain basin, manhole, or junction box. Grouted, epoxy, concrete collars, or welded connections are not permitted.

2.3 STORM DRAINAGE INLETS

- A. General: Storm drainage inlets are identified on the Drawings using the designation "I" followed by a number designation.
- B. Inlet Box:
 - 1. Cast-in-place concrete constructed in accordance with PennDOT Publication 408, Section 605 or pre-cast concrete inlet boxes manufactured in accordance with PennDOT Publication 408, Section 714.
 - 2. Pre-cast concrete inlet boxes shall be supplied by a manufacturer listed in PennDOT Bulletin 15.
 - 3. All dimensions and construction shall be in accordance with PennDOT Standards for Roadway Construction, RC-34 OR RC-45, Publication 72. Where non-standard inlet boxes are required, provide shop drawing for approval by architect prior to pre-casting or construction in place.
- C. Top Section:
 - 1. Pre-cast concrete inlet top units manufactured in accordance with PennDOT Publication 408, Section 714.
 - 2. Pre-cast concrete inlet top units shall be supplied by a manufacturer listed in PennDOT Bulletin 15.
 - 3. All dimensions and construction shall be in accordance with PennDOT Standards for Roadway Construction, RC-34 or RC-45, Publication 72. Provide top units for each inlet of PennDOT type designated on Drawings.
 - 4. Curb inlets shall be provided with top unit that matches curb reveal. Where a sump condition is indicated for the inlet, provide top unit 2-inches greater than curb reveal to permit inlet to be set in a sumped condition.
- D. Grade Rings:
 - 1. Precast concrete grade rings manufactured in accordance with PennDOT Publication 408, Section 714.
 - 2. Provide grade rings to match dimensions of inlet box in standard manufactured increments. Provide largest measurement of increment possible from standard manufactured grade rings for adjustment.
- E. Frame and Grate:

1. Structural steel meeting the requirements of PennDOT Publication 408, Section 1105.02(a)2 and Section 605.2(a) with dimensions and construction in accordance with PennDOT Standards for Roadway Construction, RC-34, Publication 72.
2. All inlet grates located within vehicular areas (drive aisles, parking areas, roadways, etc.) shall be bicycle safe. All inlet grates located within pedestrian areas (courtyards, entrances, walkways, etc.) shall be pedestrian safe in accordance with ADA standards. Contractor shall submit catalog cut sheets for each type of grate.
3. Inlet grate and frame shall fit to resist movement, rocking, and shall be level with concrete top unit when installed in frame.

2.4 STORM DRAINAGE MANHOLES

- A. General: Storm drainage manholes are identified on the Drawings using the designation MH followed by a number designation
- B. Precast Concrete Manhole Sections and Riser:
 1. Cast-in-place concrete constructed in accordance with PennDOT Publication 408, Section 605 or pre-cast manhole sections and riser manufactured in accordance with PennDOT Publication 408, Section 714
 2. Pre-cast concrete manhole sections and risers shall be supplied by a manufacturer listed in PennDOT Bulletin 15.
 3. All dimensions and construction shall be in accordance with PennDOT Standards for Roadway Construction, RC-39, Publication 72.
- C. Manhole Frame and Cover:
 1. Gray malleable or ductile iron in accordance with PennDOT Publication 408, Sections 605.2(b) and 1105.02(h) with all dimensions and construction in accordance with PennDOT Standards for Roadway Construction, RC-34, Publication 72. All manhole covers for storm drainage systems shall be stamped with the designation "storm" or "storm water" in uppercase letters.
- D. Manhole Steps:
 1. Manufactured in accordance with PennDOT Publication 408, Section 605.2(c) and all construction in accordance with PennDOT Standards for Roadway Construction, RC-39, Publication 72.

2.5 STORM DRAINAGE PIPE INTAKE AND OUTFALL STRUCTURES

- A. Headwalls and Endwalls: Headwalls or endwalls are identified on the Drawings using the designation HW or EW followed by a number designation

1. Cast-in-place concrete constructed in accordance with PennDOT Publication 408, Section 605 or pre-cast headwalls and endwalls manufactured in accordance with PennDOT Publication 408, Section 714
 2. Pre-cast concrete manhole sections and risers shall be supplied by a manufacturer listed in PennDOT Bulletin 15.
 3. All dimensions and construction shall be in accordance with PennDOT Standards for Roadway Construction, RC-31, Publication 72. Provide headwalls or endwalls for each pipe outlet or inlet of PennDOT type designated on Drawings.
 4. Provide concrete apron at all headwalls that require a trash rack or orifice plate. When required, pre-cast manufacture may deviate from standard PennDOT RC Standards to accommodate orifice plate.
- B. Trash Racks: As indicated on the Drawings.
- C. Orifice Plates: Galvanized steel sheet meeting the requirements of ASTM A466, size as dimensioned on Drawings. Use only galvanized steel accessories and hardware, ASTM A153 and ASTM A325, or stainless-steel accessories and hardware.
- D. Flared End Sections: As indicated on the Drawings.

2.6 STORM WATER UNDERGROUND DETENTION BEDS

- A. Geotextile: As specified in Section 310005 and as indicated on the Drawings.
- B. Backfill Stone: As specified in Section 310005 and as indicated on the Drawings.
- C. Pipe: As specified in Section 334000 and as indicated on the Drawings.

2.7 STORM WATER DETENTION BASINS

- A. Emergency Spillway Lining: Geotextile, as specified in Section 310005 and as indicated on the Drawings.
- B. Impervious Clay Core: Clay meeting the requirements as specified Section 310005.
- C. Anti-Seep Collars: PADOT Class A concrete, welded wire reinforcement as specified in Division 3, dimensions as indicated on Drawings. Use earth forms

2.8 ENERGY DISSIPATORS

- A. Rock Riprap: Quarried local stone, riprap gradation meeting NCSA standards for nominal size as scheduled on Drawings.
- B. Separation Fabric: Geotextile as specified in Section 310005 and as indicated on the Drawings.

2.9 PIPE BEDDING, HAUNCHING, AND COVER MATERIALS

- A. As indicated on the Drawings and as specified in Section 312000.

2.10 ACCESSORIES

- A. Mortar and Grout: Multi-purpose non-shrinking and non-staining grout used to fill voids at drainage pipe penetrations to storm drainage structures and for setting inlet top units or grade adjustment rings. Mortar or grout mix shall attain a minimum seven-day comprehensive strength of 6500 psi as measured per ASTM-C109 and a minimum 24-hour bond strength of 1500 psi as measured by ASTM-C882.

- 1. Manufactures:

- a. W.R. Meadows, Sealtight Products, CG-86 Construction Grout (1-800-342-5976).
- b. CTS Cement Manufacturing Co., Rapid Set Products, Rapid Set Non-Shrink Mortar Mix (1-800-929-3030).
- c. Capricorn Industrial Sales Co., Sto Concrete Restoration Products, Sto Non-Shrink Grout (1-610-429-5301).
- d. Substitution per Division 1 –General Requirements

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that the trench cuts and excavations for drainage structures are ready to receive the Work of this Section.
 - 1. All trenching excavation shall be performed in accordance with Section 312000. Unsuitable subgrade materials shall be determined by the Owner Geotechnical Representative and shall be removed and replaced in accordance with Section 312000.
- B. Verify that erosion and sedimentation control measures required for the Work are installed and functioning properly.

3.2 PREPARATION

- A. Hand trim excavations to required elevations. Remove rock protrusions, roots, and other inconsistencies that could affect placement and backfilling of drainage pipe or drainage structures.
- B. Remove large stones or other hard matter that could damage or impede consistent backfilling or compaction.

3.3 INSTALLATION – PIPE

- A. General Procedures:

1. Inspect all delivered pipe, fittings, couplings, and accessories for damage and conformance with the product requirements. All damaged or nonconforming material shall be rejected and removed the site.
2. Handle and store all pipe, fittings, couplings, and accessories as recommended by manufacturer. Pipe shall not be dropped from the delivery truck, into an open trench, or onto uneven surfaces. Avoid dragging or striking the pipe against another pipe or object, dragging the pipe across the ground, or driving over the pipe. Inspect all fittings and couplings before installation.
3. Backfill materials shall be free of lumps, clods, boulders, large stones, frozen matter, trash, and debris. The presence of such material may preclude uniform compaction and result in excessive localized deflections.
4. Lay pipe in uniform line in accordance with alignment and slope gradients as noted on the plans between manholes and other drainage structures with unbroken continuity of invert.
5. Start laying pipe at lowest grade and proceed upgrade.
6. Clean interior of each pipe of all foreign material before next pipe is laid.
7. Jointing: Comply with manufacturer's specifications for assembly of joint components, lubrication, and making of joints. When pipe laying is interrupted, secure piping against movement and seal open ends to prevent the entrance of water, mud, or foreign material.
 - a) Elastomeric Seal Joints: Mark, or verify that the pipe ends are marked, to indicate insertion stop position, and verify that the pipe is inserted into pipe or fitting bells to this mark. Push spigot into bell using methods approved by the manufacturer, keeping pipe true to line and grade. Protect the end of the pipe during homing and do not use excessive force that may result in dislodging the gasket or damaging joint integrity. When full entry is not achieved, disassemble and clean the joint and reassemble. Use only lubricant supplied or recommended for use by the pipe manufacturer. Do not exceed the manufacturer's limitations for joint deflection.
 - b) Solvent Cement Joints: Follow manufacturer's recommendations of both the drainage pipe and cement. Allow freshly made joints to set for the required time before moving, backfilling, or otherwise disturbing pipe.
 - c) Heat Fusion Joints: Follow manufacturer's instructions for making fused joints. Pipe may be joined at the ground surface and the lowered into position provided it is properly handled and supported in a manner that will preclude damage.
8. Placing and Compacting Backfill Material: Perform work in accordance with Section 31 20 00.
9. Vertical Risers: Provide support for vertical risers as commonly found at junctions, cleanouts, and drop manholes to prevent vertical or lateral movement. Prevent the direct transfer of thrust due to surface loads and settlement, and provide adequate support at points of connection to trunk lines. Provide concrete collar at vertical risers for cleanouts where installed in areas where structural support is not available from adjacent final pavement surfaces.

10. Connection to Existing Pipe: When excavating existing pipe for connection, excavate material from above the top of the existing pipe before removing material from the sides of the pipe. Make all cuts for connection clean and straight, remove any burrs or ragged edges, and install the drainage structure or fitting as scheduled. Backfill and compact around the connection in accordance with the specified requirements or the requirements of the authority having jurisdiction for the existing drainage line.
11. Pipe Caps and Plugs: Secure pipe caps and plugs to the ends of pipe in accordance with manufacturer's specifications.

3.4 INSTALLATION - INLETS, YARD DRAINS, MANHOLES, AND ENDWALLS

- A. Inlets (I) and Yard Drains (YD): Install inlet boxes, grade rings, and top units in accordance with the PennDOT Specifications and Construction Standards referenced in Part 2.
 1. Install inlet debris interceptor at all inlets located in roadways, parking areas, or otherwise scheduled on Drawings. Install debris interceptor on accordance with manufacturer's specifications or installation instructions.
- B. Do not use damaged, cracked, chipped, or spalled inlet boxes or top units. Repair damaged sections of inlet or manhole sections prior to backfilling to prevent deterioration with mortar or grout. Provide reinforcement meshing for repairs greater than one-inch deep. Replace inlet top sections cracked or chipped during installation that will mar appearance or damage structural integrity. Top units with cracks or chips greater than one-inch deep, where reinforcement has been exposed, or greater than two square-inches individually or as an aggregate total area measured over the entire exposed surface of top unit will be rejected.
- C. Where a curb-type inlet top is specified on Drawings, install inlet top unit so top of structure will be flush with the top of the adjacent curb and face of curbed section of structure will be flush with face of adjacent curb and will not alter line and alignment of curb. Install top unit to match vertical alignment, or longitudinal slope, of adjacent curb. Use grade rings fabricated to provide the required alignment, brick, or steel wedges as required. The required design top of grate elevation shall be considered at the middle of the inlet grate measured at the face of the curb.
- D. Manholes (MH): Install storm drainage manholes in accordance with the PennDOT Specifications and Construction Standards referenced in Part 2.
- E. Endwalls (EW or HW): Install endwalls and headwalls in accordance with the PennDOT Specifications and Construction Standards referenced in Part 2.
 1. Install trash racks at designated headwalls in accordance with manufacturer's instructions or as indicated on approved shop drawings.
 2. Install orifice reduction plate at detention basin outlet. Coat back of steel plate with bitumastic prior to securing to face of headwall with hardware as specified and detailed on Drawings. Verify orifice is at correct elevation, properly aligned with outlet pipe, and is secure to resist movement or unauthorized removal.

3.5 INSTALLATION – OUTLET PROTECTION / LEVEL SPREADER

- A. Perform excavation for placement of rock riprap outlet protection in accordance with Section 312000. Excavate to permit minimum depth of placement and configuration as scheduled on Drawings. Top of installed riprap shall be even with invert of outlet.
- B. Place gradation of riprap scheduled at each required location. Level surface after placement to fill any voids and variation in placed depth.
- C. Install geotextile fabric between the subgrade and the subsequent layers of stone riprap. Secure geotextile to prevent movement during placement of stone. Do not tear or fold over geotextile during placement of riprap.
- D. Maintenance: During construction remove accumulated sediment from outlet protection. Where voids between the riprap in the aprons have become filled with sediment, completely remove, wash riprap, and replace or remove and replace with new stone. During construction, and prior to requesting inspection for Substantial Completion, remove all weeds, accumulated trash, and other debris from the riprap aprons.

3.6 STORM WATER DETENTION BASIN

- A. The storm water detention basin shall be constructed prior to installation of any storm drainage pipe, swales, or other drainage systems that outlet to the storm water detention basin. Sequencing installation of the storm water detention basin is included in the Construction Sequence provided on the Erosion and Sedimentation Control Plan.
- B. Perform all clearing and topsoil stripping as specified in Section 311000. Divert upland drainage around the area required for construction.
- C. Perform general excavating and backfilling procedures as specified in Section 312000. Construct all fills with General Fill material as specified in Section 310005. Place fill in maximum six-inch lifts and compact following each lift.
- D. Excavate cut-off trench as dimension on Drawings for all storm water detention basin berms constructed in a fill condition.
- E. Install impervious clay core when specified on drawings. Clay material shall be as specified in Section 310005. Place core material in maximum six-inch lifts and compact following each lift.
- F. Excavate and shape earth berm spillways and outlet channels to the dimensions on the Drawings. Immediately stabilize earth berm spillways and exit channels with geotextile fabric when required on Drawings.
- G. Install drainage pipe through berm in accordance with specified storm drainage pipe installation procedures. Install anti-seep collars at the locations dimensioned on the Drawings. Install headwalls, endwalls, and outlet protection.

- H. Where required by the Erosion and Sediment Control Plan, provide a temporary outlet control measures, over excavation for sediment storage, filters, temporary seeding, and other measures as identified on the Erosion and Sediment Control Plan. All areas of the detention basin that are at finish grade and will not require additional disturbance shall have topsoil installed, be fine graded, and landscaped as specified. Install final outlet control device and trash rack only after upland areas are permanently stabilized and approval to remove the temporary controls is received from the county Conservation District.
- I. Maintenance: During construction, remove sediment to maintain required storage volume and perform other maintenance operations as required by the Erosion and Sediment Control Plan or local Conservation District.
- J. Basin Conversion: Contractor shall convert the sediment basin to the permanent infiltration basin per the plans. Confirmation infiltration testing is required per the NPDES permit and the Contractor is responsible for scheduling and all costs related to the infiltration testing.

3.7 UNDERGROUND STORM WATER DETENTION BED

- A. The underground storm water detention bed shall be constructed prior to installation of any storm drainage pipe, swales, or other drainage systems that outlet to the storm water detention bed. Sequencing installation of the storm water detention bed is included in the Construction Sequence provided on the Erosion and Sedimentation Control Plan.
- B. Perform all clearing and topsoil stripping as specified in Section 311000. Divert upland drainage around the area required for construction.
- C. Perform general excavating and backfilling procedures as specified in Section 312000.
- D. The Contractor shall not allow any heavy excavation equipment on the bottom of the bed. A track hoe must excavate from outside the bed unless low compaction equipment is used and the specific methods have been authorized by the Owner. Any compaction of the bottom of the bed may cause the underground bed to fail to infiltrate.
- E. Install drainage pipe within the bed in accordance with specified storm drainage pipe installation procedures and manufacturers requirements. Install headwalls, endwalls, outlet structures and outlet protection.
- F. Maintenance: Inlet erosion control devices shall not be removed until the contributing drainage area to the bed has been stabilized in accordance with the plans. The Contractor shall be responsible for replacing and/or cleaning the erosion control devices until this has occurred. Permanent inlet filters shall not be installed until the site has been determined stabilized by the conservation district.

3.8 COMPACTION AND FIELD QUALITY CONTROL:

- A. Inspection: Provide for visual inspection prior to backfilling storm drainage pipe and structures. Verify that pipe is properly aligned, all fittings and connections are secure, and that pipe is securely seated in openings of drainage structures. Verify that drainage structures are in proper position, capable of supporting backfill loads, and will resist movement during backfilling:
- B. Testing: During the course of trench backfilling and compaction, Architect may, at various locations or depths of backfill, have density tests performed to verify compaction meets specified requirements.
- C. General Requirements: As specified in Section 312000.
 - 1. Compaction methods are the sole responsibility of the Contractor and shall be at his discretion in regard to meeting the specified compaction requirements.
 - 2. Add water to assist in compaction when required. Allow excessively wet backfill materials to air dry to acceptable moisture range when required prior to backfilling.

3.9 PROTECTION OF FINISHED WORK

- A. Protect pipe and aggregate cover from damage or displacement until final backfilling operation is in progress.
- B. Protect open end of pipe when day's work has been completed and or where installation has been temporarily halted.
- C. Protect pipe, joints, and connections during installation. Do not damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.
- D. Replace or repair damaged drainage pipe, joints, couplings, and storm drainage structures damaged during the Work.
- E. Temporary Cover: Provide additional temporary soil or aggregate cover over installed pipe at locations where construction equipment will pass over pipe and exceed an H20 design load condition.
 - 1. A minimum of three-feet of cover over the crown of the pipe is required when drainage pipe will be crossed by construction vehicles weighing more than twenty tons. Excessive loading conditions, such as those imparted by cranes and other heavy construction equipment, shall be reviewed with the pipe manufacturer and Architect before such loading conditions will be permitted.
 - 2. Review the locations of all intended cross-over points with Architect.

END OF SECTION

