

# **PROJECT MANUAL**

# FOR

# URBANA ELEMENTARY SCHOOL



# BID SET

January 10, 2019

# **VOLUME 4 OF 4**

Division 26 Through 33

TOC TABLE OF CONTENTS

# VOLUME 1

DIVISION 00 - CONTRACT REQUIREMENTS (Not Included in this Submission)

- 00 01 15 LIST OF DRAWING SHEETS
- 00 11 16 INVITATION TO BID
- 00 11 18 FCPS MAP & 2017-2018 FCPS CALENDAR
- 00 43 43 PREVAILING WAGE REQUIREMENTS
- 00 21 13 INSTRUCTIONS TO BIDDERS, AIA DOCUMENT A701, 1997 EDITION
- 00 22 13 FCPS SUPPLEMENTAL INSTRUCTION TO BIDDER (SUPPLEMENT TO AIA DOCUMENT A701)
- 00 24 13 SPECIFICATION CROSS-REFERENCE
- 00 24 16 CONTRACT PACKAGES
- 00 31 13 PRELIMINARY CONSTRUCTION SCHEDULE
- 00 42 00 FORM OF PROPOSAL
- 00 42 43 CAPITAL EQUIPMENT INFORMATIONAL UNIT PRICES
- 00 43 13 BID BOND AIA DOCUMENT A310, 2010 EDITION
- 00 45 19 STATUTORY AFFIDAVIT AND NON-COLLUSION CERTIFICATION
- 00 43 25 CERTIFICATION OF COMPLIANCE
- 00 45 39 CERTIFIED MBE UTILIZATION AND FAIR SOLICITATION AFFIDAVIT -ATTACHMENT "A"
- 00 45 39.01 MBE PARTICIPATION SCHEDULE ATTACHMENT "B"
- 00 52 26 AIA DOCUMENT A132-CMa, 2009 STANDARD FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR, CONSTRUCTION MANAGER AS ADVISOR
- 00 72 26 AIA DOCUMENT A232 2009 GENERAL CONDITIONS OF THE CONTRACT OF CONSTRUCTION, CONSTRUCTION MANAGER AS ADVISOR
- 00 61 13 MARYLAND COMAR 21.07.02.10 PERFORMANCE AND PAYMENT BONDS
- 00 62 39 MBE REGULATION NO. 200-8

# VOLUME 2

# **DIVISION 01 - GENERAL REQUIREMENTS**

- 01 10 00 SUMMARY
- 01 20 00 PRICE AND PAYMENT PROCEDURES
- 01 23 00 ALTERNATE BIDS
- 01 30 00 ADMINISTRATIVE REQUIREMENTS
- 01 31 14 FACILITY SERVICES COORDINATION
- 01 32 16 CONSTRUCTION PROGRESS SCHEDULE
- 01 35 53 SECURITY PROCEDURES
- 01 40 00 QUALITY REQUIREMENTS
- 01 50 00 TEMPORARY FACILITIES AND CONTROLS
- 01 51 00 TEMPORARY UTILITIES
- 01 52 13 FIELD OFFICES AND SHEDS
- 01 55 00 VEHICULAR ACCESS AND PARKING
- 01 58 13 TEMPORARY PROJECT SIGNAGE

- 01 60 00 PRODUCT REQUIREMENTS
- 01 70 00 EXECUTION AND CLOSEOUT REQUIREMENTS
- 01 74 19 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT AND DISPOSAL
- 01 77 00 CLOSEOUT PROCEDURES
- 01 78 00 CLOSEOUT SUBMITTALS
- 01 79 00 DEMONSTRATION AND TRAINING
- 01 81 13 SUSTAINABLE DESIGN REQUIREMENTS LEED LEED SCORECARD LEED v4 LOW-EMITTING MATERIALS SUBMITTAL FORM LEED v4 MATERIALS AND RESOURCES SUBMITTAL FORM, BPDO: Environmental Product Declarations, Option 1
  - LEED v4 MATERIALS AND RESOURCES SUBMITTAL FORM, BPDO: Sourcing of Raw Materials, Option 2
  - LEED v4 MATERIALS AND RESOURCES SUBMITTAL FORM, BPDO: Material Ingredients, Option 1
- 01 91 13 GENERAL COMMISSIONING REQUIREMENTS
- 01 91 15 FUNCTIONAL PERFORMANCE TEST REQUIREMENTS

# **DIVISION 02 - EXISTING CONDITIONS**

# 02 30 00 SUBSURFACE DRILLING AND SAMPLING INFORMATION

# **DIVISION 03 - CONCRETE**

03 10 00	CONCRETE FORMING AND ACCESSORIES
03 20 00	CONCRETE REINFORCING
03 30 00	CAST-IN-PLACE CONCRETE
03 35 13	CONCRETE FLOOR FINISHING

03 35 13 CONCRETE FLOOR FINIS 03 39 00 CONCRETE CURING

# **DIVISION 04 - MASONRY**

- 04 72 00 CAST STONE MASONRY
- 04 73 23 MANUFACTURED STONE CLADDING

# **DIVISION 05 - METALS**

- 05 12 00 STRUCTURAL STEEL FRAMING
- 05 21 00 STEEL JOIST FRAMING
- 05 31 00 STEEL DECKING
- 05 40 00 COLD-FORMED METAL FRAMING
- 05 44 00 COLD-FORMED STEEL TRUSSES
- 05 50 00 METAL FABRICATIONS
- 05 51 00 METAL STAIRS
- 05 51 19 METAL GRATING STAIRS
- 05 52 13 PIPE AND TUBE RAILINGS
- 05 53 20 STAIR NOSINGS
- 05 58 13 COLUMN COVERS

# **DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES**

- 06 10 00 ROUGH CARPENTRY
- 06 20 00 FINISH CARPENTRY
- 06 41 00 ARCHITECTURAL WOOD CASEWORK

#### **DIVISION 07 - THERMAL AND MOISTURE PROTECTION**

- 07 13 00 SHEET WATERPROOFING
- 07 16 16 CRYSTALLINE WATERPROOFING
- 07 18 00 TRAFFIC COATINGS
- 07 21 00 THERMAL INSULATION
- 07 21 27 ENCLOSED CAVITY FOAMED INSULATION
- 07 27 15 NON-BITUMINOUS SELF-ADHERING SHEET AIR BARRIERS
- 07 31 13 ASPHALT SHINGLES
- 07 42 13 METAL WALL PANELS
- 07 51 00 BUILT-UP ASPHALT ROOFING
- 07 62 00 SHEET METAL FLASHING AND TRIM
- 07 71 00 MANUFACTURED ROOF SPECIALTIES
- 07 71 23 DOWNSPOUTS
- 07 72 00 ROOF ACCESSORIES
- 07 84 00 FIRESTOPPING
- 07 84 46 FIRE-RESISTIVE JOINT SYSTEMS
- 07 90 05 JOINT SEALERS
- 07 95 13 EXPANSION JOINT COVER ASSEMBLIES

**DIVISION 08 - OPENINGS** 

- 08 11 13 HOLLOW METAL DOORS AND FRAMES
- 08 14 16 FLUSH WOOD DOORS
- 08 31 00 ACCESS DOORS AND PANELS
- 08 33 13 COILING COUNTER DOORS
- 08 33 23 OVERHEAD COILING DOORS
- 08 43 13 ALUMINUM-FRAMED STOREFRONTS
- 08 45 13 STRUCTURED-POLYCARBONATE-PANEL ASSEMBLIES
- 08 71 00 FINISH HARDWARE
- 08 80 00 GLAZING
- 08 91 00 LOUVERS

#### **DIVISION 09 - FINISHES**

- 09 21 16 GYPSUM BOARD ASSEMBLIES
- 09 22 16 NON-STRUCTURAL METAL FRAMING
- 09 30 00 TILING
- 09 51 00 ACOUSTICAL CEILINGS
- 09 52 50 INTERACTIVE ACOUSTICAL PANEL SYSTEM
- 09 54 50 FRP CEILING SYSTEM
- 09 65 00 RESILIENT FLOORING
- 09 65 10 HYBRID RESILIENT FLOORING
- 09 65 66 RESILIENT ATHLETIC FLOORING
- 09 66 23 RESINOUS MATRIX TERRAZZO FLOORING

- 09 67 00 FLUID-APPLIED FLOORING
- 09 67 10 SELF-LEVELING POLYURETHANE FINISH SYSTEM
- 09 84 00 ACOUSTIC PANELS
- 09 91 23 INTERIOR PAINTING
- 09 93 00 STAINING AND TRANSPARENT FINISHING
- 09 96 00 HIGH-PERFORMANCE COATINGS

# **DIVISION 10 - SPECIALTIES**

- 10 11 01 VISUAL DISPLAY BOARDS
- 10 11 25 BULLETIN BOARDS AND DISPLAY CASES
- 10 14 00 SIGNAGE
- 10 21 13.19 PLASTIC TOILET COMPARTMENTS
- 10 21 23 CUBICLES
- 10 22 26 ACCORDION FOLDING PARTITIONS
- 10 22 26.33 FOLDING PANEL PARTITIONS
- 10 26 00 DECORATIVE SEMI-RIGID WALL COVERING
- 10 28 00 TOILET, BATH, AND LAUNDRY ACCESSORIES
- 10 44 00 FIRE PROTECTION SPECIALTIES
- 10 50 00 LOCKERS
- 10 56 13 METAL STORAGE SHELVING
- 10 75 00 FLAGPOLES

# **DIVISION 11 - EQUIPMENT**

- 11 00 05 MISCELLANEOUS EQUIPMENT
- 11 13 13 LOADING DOCK BUMPERS
- 11 31 00 APPLIANCES
- 11 40 00 FOODSERVICE EQUIPMENT
- 11 51 23 LIBRARY STACK SYSTEMS
- 11 52 13 PROJECTION SCREENS
- 11 61 43 PLATFORM CURTAINS
- 11 66 23 GYMNASIUM EQUIPMENT
- 11 66 43 BASKETBALL SCOREBOARD
- 11 66 53 GYMNASIUM DIVIDER
- 11 67 33 MODULAR CLIMBING WALLS

# **DIVISION 12 - FURNISHINGS**

- 12 24 13 WINDOW SHADE SYSTEMS
- 12 35 50 EDUCATIONAL CASEWORK
- 12 35 51 MUSICAL INSTRUMENT STORAGE CABINETS
- 12 36 00 COUNTERTOPS
- 12 48 13 ENTRANCE FLOOR MATS AND FRAMES
- 12 93 00 SITE FURNISHINGS

# **DIVISION 14 - CONVEYING EQUIPMENT**

# 14 24 00 PASSENGER ELEVATORS

# **VOLUME 3**

# **DIVISION 21 - FIRE SUPPRESSION**

- 210500 COMMON WORK RESULTS FOR FIRE SUPPRESSION
- 211313 WET-PIPE SPRINKLER SYSTEMS
- 213113 ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS
- 213400 PRESSURE-MAINTENANCE PUMPS
- 213900 CONTROLLERS FOR FIRE-PUMP DRIVERS

# **DIVISION 22 - PLUMBING**

- 220500 COMMON WORK RESULTS FOR PLUMBING
- 220513 COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT
- 220519 METERS AND GAUGES FOR PLUMBING PIPING
- 220523 GENERAL-DUTY VALVES FOR PLUMBING PIPING
- 220529 HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
- 220533 HEAT TRACING FOR PLUMBING PIPING
- 220548 VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT
- 220553 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
- 220700 PLUMBING INSULATION
- 221116 DOMESTIC WATER PIPING
- 221119 DOMESTIC WATER PIPING SPECIALTIES
- 221316 SANITARY, WASTE AND VENT PIPING
- 221319 SANITARY WASTE PIPING SPECIALTIES
- 221413 FACILITY STORM DRAINAGE PIPING
- 221423 STORM DRAINAGE PIPING SPECIALTIES
- 221429 SUMP PUMPS
- 223400 FUEL-FIRED, DOMESTIC-WATER HEATERS
- 224213.13 COMMERCIAL WATER CLOSETS
- 224213.16 COMMERCIAL URINALS
- 224216.13 COMMERCIAL LAVATORIES
- 224216.16 COMMERCIAL SINKS
- 224223 COMMERCIAL SHOWERS, RECEPTORS, AND BASINS
- 224716 PRESSURE WATER COOLERS

#### DIVISION 23 - HEATING, VENTILATING & AIR CONDITIONING

230500	COMMON WORK RESULTS FOR HVAC
230513	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
230519	METERS AND GAUGES FOR HVAC PIPING
230523	GENERAL-DUTY VALVES FOR HVAC PIPING
230529	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
230548	VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT
230553	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
230593	TESTING, ADJUSTING AND BALANCING FOR HVAC
230713	DUCT INSULATION
230716	HVAC EQUIPMENT INSULATION
230719	HVAC PIPING INSULATION
230800	MECHANICAL SYSTEM COMMISSIONING
220950	DUIL DING AUTOMATION SVETEM COMMERCIONING

230859 BUILDING AUTOMATION SYSTEM COMMISSIONING

230900	INSTRUMENTATION AND CONTROL FOR HVAC
231123	FACILITY NATURAL-GAS PIPING
232113	HYDRONIC PIPING
232113.33	GROUND-LOOP HEAT PUMP PIPING
232123	HYDRONIC PUMPS
232300	REFRIGERANT PIPING
232500	HVAC WATER TREATMENT
233113	METAL DUCTS
233300	AIR DUCT ACCESSORIES
233423	HVAC POWER VENTILATORS
233433	AIR CURTAINS
233713	DIFFUSERS, REGISTERS, AND GRILLES
233723	HVAC GRAVITY VENTILATORS
237200	ENERGY RECOVERY AIR HANDLING UNITS/DEDICATED OUTDOOR AIR UNITS
237313	MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS
238126	SPLIT-SYSTEM AIR-CONDITIONERS
238129	VARIABLE REFRIGERANT FLOW HVAC SYSTEM
238233	CONVECTORS
238239	UNIT HEATERS

# **VOLUME 4**

**DIVISION 26 - ELECTRICAL** 

260500	BASIC ELECTRICAL MATERIALS AND METHODS
260501	GENERAL ELECTRICAL REQUIREMENTS
260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
260533	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
260543	UNDERGROUND DUCTBANKS
260548	VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS
260573	OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
260800	ELECTRICAL SYSTEM COMMISSIONING
260923	LIGHTING CONTROL DEVICES
260943	NETWORK LIGHTING CONTROLS
262200	LOW-VOLTAGE TRANSFORMERS
262413	SWITCHBOARDS
262416	PANELBOARDS
262726	WIRING DEVICES
262743	ELECTRIC-VEHICLE SERVICE EQUIPMENT – AC LEVEL 1 AND LEVEL 2
262813	FUSES
262816	ENCLOSED SWITCHES AND CIRCUIT BREAKERS
262913	ENCLOSED CONTROLLERS
263213	ENGINE GENERATORS
263600	TRANSFER SWITCHES
264113	LIGHTNING PROTECTION SYSTEM
264300	SURGE PROTECTION DEVICES (SPD)
265100	INTERIOR LIGHTING
265600	EXTERIOR LIGHTING

# **DIVISION 27 - COMMUNICATIONS**

- 27 05 00 COMMON WORK RESULTS FOR COMMUNICATIONS
- 27 11 00 COMMUNICATIONS EQUIPMENT ROOM FITTINGS
- 27 13 00 SOUND SYSTEMS
- 27 15 00 VOICE OVER INTERNET PROTOCOL (VoIP) AND DATA SYSTEMS
- 27 51 23 INTEGRATED TELECOMMUNICATIONS SYSTEM
- 27 70 00 EMERGENCY RADIO IN-BUILDING AMPLIFICATION SYSTEM

# **DIVISION 28 - ELECTRONIC SAFETY AND SECURITY**

- 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY
- 28 16 05 INTEGRATED CCTV SURVEILLANCE SYSTEM
- 28 23 01 INTEGRATED INTRUSION DETECTION SYSTEM
- 283111 FIRE ALARM SYSTEM (ADDRESSABLE TYPE)

# **DIVISION 31 - EARTHWORK**

- 31 10 00 CLEARING
- 31 20 00 EARTHMOVING
- 31 20 05 BUILDING EARTHWORK
- 31 31 16 TERMITE CONTROL
- 31 50 00 EXCAVATION SUPPORT AND PROTECTION

# **DIVISION 32 - EXTERIOR IMPROVEMENT**

- 32 12 16 HOT-MIXED ASPHALT PAVING
- 32 12 20 ROAD AND PARKING ACCESSORIES
- 32 13 13 CONCRETE PAVING
- 32 13 15 CONCRETE CURBING
- 32 30 00 SITE FURNISHINGS
- 32 30 10 MODULAR PLAYGROUND EQUIPMENT
- 32 31 13 CHAIN LINK FENCES AND GATES
- 32 32 23 SEGMENTAL RETAINING WALLS
- 32 90 00 TREE CONSERVATION
- 32 93 05 TOPSOILING, SEEDING AND SODDING
- 32 95 00 TREES, SHRUBS AND GROUND COVERS

# **DIVISION 33 - UTILITIES**

- 33 10 00 UTILITY STANDARDS
- 33 10 05 WATER DISTRIBUTION SYSTEM
- 33 30 00 SANITARY SEWERAGE
- 33 32 23 BASE MOUNTED PUMPING STATION
- 33 41 00 STORM DRAINAGE

# END OF TABLE OF CONTENTS

# **SECTION 260500**

# BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Electrical equipment coordination and installation.
  - 2. Sleeves for raceways and cables.
  - 3. Sleeve seals.
  - 4. Grout.
  - 5. Common electrical installation requirements.

#### 1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

#### 1.4 SUBMITTALS

A. Product Data: For sleeve seals.

#### 1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  - 3. To allow right of way for piping and conduit installed at required slope.
  - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Through-Penetration Firestop Systems."

# PART 2 - PRODUCTS

# 2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
    - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

# 2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
  - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
  - Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

# 2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

# PART 3 - EXECUTION

#### 3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

# 3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways 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 inches (50 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway 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 raceway 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 raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Through-Penetration Firestop Systems."

- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) 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-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

# 3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use 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.

#### 3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Through-Penetration Firestop Systems."

# END OF SECTION 260500

# **SECTION 260501**

#### GENERAL ELECTRICAL REQUIREMENTS

#### PART 1 - GENERAL

#### 1.1 GENERAL

- A. Provide all labor, materials, equipment and services necessary for and incidental to the complete installation and operation of all electrical work.
- B. All work under this Division is subject to the General Conditions and Special Requirements for the entire contract.
- C. Unless otherwise specified, all shop drawings and submissions required under Division 26 shall be made to, and acceptances and approvals made by, the ENGINEER.
- D. Conform to the requirements of all rules, regulations, and codes of local, state, and federal authorities having jurisdiction. Conform to the National Electrical Code and all NECA National Electrical Installation Standards (NEIS).
- E. Perform the work in a first-class, substantial, and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer, at the Contractor's expense.
- F. Coordinate the work of all trades.
- G. Arrange conduit, wiring, equipment, and other work generally as shown, providing proper clearances and access. Carefully examine all contract drawings and fit the work in each location without substantial alteration. Where departures are proposed because of field conditions or other causes, prepare and submit detailed drawings for approval in accordance with "Submittals" specified below. The right is reserved to make reasonable changes in location of equipment, conduit, and wiring up to the time of rough-in or fabrication.
- H. The contract drawings are generally diagrammatic and all offsets, bends, fittings, and accessories are not necessarily shown. Provide all such items as may be required to fit the work to the conditions.
- I. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in a first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the Contract Documents.
- J. The Contractor shall provide other work and services not otherwise included in the Contract Documents that are customarily forwarded in accordance with generally-accepted construction practices.
- 1.2 PERMITS, INSPECTIONS, AND FEES:
  - A. The Contractor shall obtain and pay for all charges and fees, and deliver all permits, licenses, certificates of inspection, etc., required by the authorities having jurisdiction. Deliver inspection, approval, and other certificates to the Owner prior to final acceptance of the work.
  - B. File necessary plans, prepare documents, give proper notices, and obtain necessary approvals.

- C. Permits and fees shall comply with the General Requirements of the Specification.
- D. Notify Inspection Authorities to schedule inspections of work. All work shall be subject to field inspections.
- E. Notify Architect in advance of scheduled inspections.
- F. An electrical foreman, superintendent or other supervisor shall be in attendance for all scheduled inspections.
- G. The Contractor shall provide an electrical certificate from an independent electrical inspection agency approved by the Owner and the State of Maryland Fire Marshal. The Contractor shall submit certificate prior to final payment invoice. The Contractor shall pay all fees, including filing fees.

# 1.3 ELECTRICAL WORK UNDER OTHER DIVISIONS:

- A. Mechanical Equipment and Systems
  - 1. In general, power wiring and motor starting equipment for mechanical equipment and systems are furnished and installed under Electrical Division 26.
  - 2. Certain mechanical units contain starters, contacts, transformers, fuses, wiring, etc., required for fans, pumps, etc., furnished with the equipment from the factory. When this equipment is supplied from the factory, the Contractor must supply power circuit(s) to the unit and a disconnecting means. Coordinate with Contractor so that one, and only one, set of starters, fuses, switches, etc., is provided and installed.
  - 3. In general, control and interlock equipment for HVAC systems (including associated wiring, conduit, transformers, relays, contacts, etc.) is furnished under Mechanical Divisions. Contractor shall install and connect all such equipment as necessary.
  - 4. Controls, wiring, conduit, transformers, etc., for smoke, fire, and motor-operated dampers are provided by Mechanical. Electrical shall install and connect all such equipment.
- B. Architectural Equipment: In general, any electrically operated or controlled equipment furnished under architectural divisions shall be supplied with control wiring, transformers, contacts, etc. Contractor shall provide power circuits to such equipment and install all electrical control equipment related thereto.
- C. Carefully review the contract documents and coordinate the electrical work under the various Divisions.

#### 1.4 CONTRACTOR QUALIFICATION:

- A. Any Contractor or Subcontractor performing work under this Division shall be prequalified and approved by FCPS prior to the bid opening. Submit the following evidence for approval:
  - 1. A list of not less than five (5) comparable projects that the Contractor completed.
  - 2. Letters of reference from not less than three (3) registered professional engineers, contractors, or building owners, explaining Contractor proficiency, quality of work, or other attribute on projects of similar size or substance.
  - 3. Local or State license.
  - 4. Membership in trade or professional organization where required.
  - 5. Copy of Master Electrician's License.

- B. Contractor is any individual, partnership, corporation, or firm performing work by Contract or subcontract on this project.
- C. Acceptance of a subcontractor will not relieve the Contractor of any contractual requirements or his responsibility to supervise and coordinate the various trades.
- D. Supervisory Qualifications: The electrical work on the project shall be under the direct supervision of a licensed Master Electrician.
- E. Qualifications of Installers:
  - 1. For the actual fabrication, installation, and testing of the work, the Contractor shall use only thoroughly trained and experienced personnel who are completely familiar with the requirements of this work and with the installation recommendations of the manufacturers of the specified items.
  - 2. The Electrical Installer shall utilize a full time project foreman in charge of all electrical work. This person shall be fully qualified and experienced in such work and shall be available, on site, at all times during Construction. All problems, questions, coordination, etc., relating to electrical work shall take place through this person to the Architect.
- F. Qualifications of Video Tape Technician: For videotaping specified in "Operating Instructions", the Contractor shall provide the services of persons skilled in videotape production and editing.

#### 1.5 FIRE SAFE MATERIALS:

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA, or ASTM Standards for Fire Safety with Smoke and Fire Hazard Rating not exceeding flame spread of 25 and smoke developed of 50.

#### 1.6 REFERENCED STANDARDS, CODES, ORDINANCES AND SPECIFICATIONS

A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.

ADA	Americans with Disabilities Act					
ANSI	American National Standards Institute					
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers					
ASME	American Society of Mechanical Engineers					
ASTM	American Society for Testing and Materials					
IBC	International Building Code					
САВО	Council of American Building Officials					
FM	Factory Mutual					
IEEE	Institute of Electrical and Electronics Engineers					

MOSHA	Maryland Occupational Safety & Health Administration				
NEC	National Electrical Code				
NECA	National Electrical Contractors Association				
NEMA	National Electrical Manufacturers Association				
NFPA	National Fire Protection Association				
OSHA	Occupational Safety & Health Administration				
PECO	Potomac Edison				
UL	Underwriters Laboratories				

- B. All electrical equipment and materials shall comply with the Codes and Standards listed in the latest edition of IEEE Standard 241, *Electric Power Systems in Commercial Buildings*, Chapter 1, Section 1.6, entitled "Codes and Standards".
- C. Comply with all Codes applicable to the work:
  - 1. Bidders shall inform themselves of all local and state codes and regulations.
  - 2. In case of conflict between Contract Documents and governing Codes, the most stringent shall take precedence. Where, in any specific case, different sections of any applicable codes or when Drawings and Specifications specify different materials, methods of Construction, or other requirements, the most restrictive shall govern.
  - 3. Where Contract Documents exceed minimum Code requirements, and are permitted under the Code, the Contract Documents take precedence and shall govern.
  - 4. No extra payment will be allowed for work or changes required by local Code enforcement authorities.
- D. Underwriters Laboratories Labels shall apply to all materials and devices, etc., except specified items not covered by existing UL Standards.
- E. Conflicts with applicable regulations:
  - 1. Resolve at Contractor's expense.
  - 2. Prepare and submit details of alternate construction:
    - a. Acceptable solution of conflict.
    - b. List of substitute materials:

For approval of inspecting authorities. For approval of Engineer.

F. Comply with all NECA's National Electrical Installation Standards (NEIS), including NECA 1-2000 "Standard Practices for Good Workmanship in Electrical Contracting".

#### 1.7 INTERPRETATION OF DOCUMENTS

A. Any discrepancies between Drawings, Specifications, Drawings and Specifications, or within Drawing and Specifications shall be promptly brought to the attention of the Owner during the bidding period. No allowance shall subsequently be made to the Contractor by reason of his failure to have brought said discrepancies to the attention of the Owner during the bidding period or of any error on the Contractor's part.

- B. The locations of products shown on Drawings are approximate. The Contractor shall place the devices to eliminate all interference with above-ceiling ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Owner.
- C. All general trades and existing conditions shall be checked before installing any outlets, power wiring, etc.
- D. Equipment sizes shown on the Drawings are estimated. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements and install wire, conduit, or other item of the correct size for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the Owner.
- E. Where variances occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quality, or higher cost shall be included in the Contract Price. The Engineer will decide on the item and manner in which the work shall be installed.
- F. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions, and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed Shop Drawings for approval in accordance with "submittals" specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.
- G. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Owner.

# PART 2 - PRODUCTS

#### 2.1 MATERIALS AND EQUIPMENT

- A. Material and equipment installed as a part of the permanent installation shall be new, unless otherwise indicated or specified, and shall be approved by the Underwriters' Laboratories, Inc., for installation in each particular case where standards have been established.
- B. Where material or equipment is identified by proprietary name, model number, and/or manufacturer, furnish the named item or equivalent thereof, subject to acceptance.
- C. Material submissions shall conform to requirements outlined in SUBMITTALS, REVIEW, AND ACCEPTANCE.
- D. The suitability of named item only has been verified. Where more than one Manufacturer is named, only the first named Manufacturer has been verified as suitable. Manufacturers and items other than the first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement, and application. The Contractor, by providing other than the first named Manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation.

- E. The Contractor shall only submit those manufacturers indicated in the Specification. Proposed alternate manufacturers will not be considered unless the specific item indicates "or as approved equal". Submit all data necessary to determine suitability of substituted items for approval.
- F. All items of equipment furnished shall have a service record of at least five (5) years.

# 2.2 SUBSTITUTIONS

- A. Substituted items or items other than those named shall be equal or better in quality and performance and must be suitable for the available space, required arrangement, and application. Submit any and all data necessary to determine the suitability of substituted items. The Contractor shall be responsible for correct application, placement, and installation of substituted equipment. Cost savings data shall also be submitted with submittal data for substituted items. Total cost savings or a per-unit saving to the Owner shall be clearly indicated. If a substituted item is accepted, all cost savings shall be returned to the Owner as a credit.
- B. Substitutions will not be permitted for specific items of material or equipment where specifically indicated.
- C. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action (or replacement with the specified item) while maintaining the specification requirements if differences have not been clearly indicated in the submittal.
- D. Where the Contractor proposes to use an item of equipment or application other than that specified or detailed on the Drawings, which requires any redesign of the structure, partitions, foundation, HVAC, piping, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign and all new drawings and detailing required thereafter shall be prepared by the Contractor at his own expense for review by the Owner representative before any such work is implemented.
- E. All Contractor-proposed changes and revisions shall be at the Contractor's risk and expense. The Contractor shall fully coordinate all revisions, substitutions and changes with other trades. The Contractor shall provide all necessary provisions, including HVAC, ventilation, foundations, access, etc., for a complete, code compliant, and fully functional installation.
- F. Where the Contractor elects to submit a substitution for equipment or materials, he shall:
  - 1. Submit Shop Drawings that show complete compliance to each statement or requirement of the Specifications.
  - 2. Submit certified test data from an independent testing laboratory for each product.
  - 3. Submit one complete working sample of the equipment or materials to be furnished. In cases involving large or heavy items of equipment, the Owner may waive the requirement to submit the sample.
- G. Failure to comply with the above-required submissions shall constitute an automatic rejection of the substitution.

#### 2.3 SUBMITTALS, REVIEW, AND ACCEPTANCE

- A. General:
  - 1. The equipment, material, installation, workmanship, arrangement of work, final instruction, and final documentation is subject to review and acceptance. No substitution

will be permitted after acceptance of equipment or materials except where such substitution is considered by the Engineer to be in the best interest of the Owner. Submit for review in clear and legible form the following documents:

- a. Material and Equipment List
- b. Descriptive Data
- c. Shop Drawings
- d. Installation and Coordination Drawings
- e. Contractor As-Built Drawings
- f. Owner Instructions and Manuals
- g. Construction Phasing and Outage Schedule
- 2. Prepare all submittals specifically for this project and stamp each submittal in a form indicating that the documents have been Contractor reviewed, are complete, and are in compliance with the requirements of the plans and specifications. Each submittal item shall be clearly identified and numbered. Each submittal shall contain a complete schedule of Manufacturer's part numbers and quantity listings of all supplied components. Each proposed item shall be highlighted and tagged with a star, an arrow, etc., including all options and accessories.
- 3. Coordinate the installation requirements and any mechanical requirements for the equipment submitted. Submittals will be reviewed for general compliance with design concept in accordance with the contract documents. The Contractor is responsible for the correctness of all submittals. Reviews will not verify dimensions, quantities, or other details.
- 4. Identify all submittals, indicating the intended application, location, or service of the submitted item. Refer to specification sections or paragraphs where applicable. Clearly indicate the exact type, model number, size, and special features of the proposed item. Clearly list on the first page of the Submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action (or replacement with the specified item) while maintaining the specification requirements, if differences have not been clearly indicated in the submittal. Submittals of a general nature will not be acceptable.
- 5. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Indicate all options used to meet the specifications. It is not the responsibility of the Engineer or Owner to make selections of factory options other than colors. Submittals lacking proper selection of factory options or special features required by the specification shall be RETURNED WITHOUT REVIEW.
- 6. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted.
- 7. Documents of general form indicating options shall be clearly marked to show what is specifically proposed for this project.
- 8. Submittals NOT IN COMPLIANCE with the requirements of this section will be RETURNED WITHOUT REVIEW.
- B. Material, Equipment, Manufacturer and Subcontractor List: Within 30 calendar days after the award of contract, submit a complete MATERIAL, EQUIPMENT, MANUFACTURER AND SUBCONTRACTOR LIST for preliminary review. List all proposed materials and equipment, the associated proposed Manufacturer, and any proposed subcontractors. After the receipt of reviewed Material and Equipment List, submit complete Shop Drawings for approval. List all materials and equipment, indicating manufacturer, type, class, model, curves, and other general identifying information. Submittals shall be specific for each building as contained in the individual building Specifications and Drawings.
- C. Upon approval of the List of Materials, the Contractor shall prepare a complete Master Submittal Register, listing all products and materials that will be submitted for approval. Items shall be listed by referenced specification paragraph in ascending order. This master list shall be included with

each submittal, updated to reflect the status of approval for each item, and shall highlight the items pertaining to the submittal. A suggested Submittal Register Format is shown below:

SUBMITTAL REGISTER					
Item/Material	Ref'd Spec. Paragraph	Specified or Substitute	Submittal Date	Status	Remarks

- D. No Shop Drawing Submittals will be considered for approval until the complete List of Subcontractors and the complete List of Materials/Manufacturers and Equipment have been approved.
- E. Descriptive Data: After acceptance of the MATERIAL and EQUIPMENT LIST, submit additional DESCRIPTIVE DATA for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, installation instructions, and any other information necessary to indicate complete compliance with the contract documents. Where several ratings or sizes are shown or available, clearly indicate the exact size or rating relating to the particular device being proposed.
- F. Submit complete descriptive data for all items. Data shall consist of Specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, specific electrical/wiring requirements and connections including control and interlock wiring, installation instructions, and any other information necessary to indicate complete compliance with the Contract Documents. Edit submittal data specifically for application to this project.
- G. Shop Drawings shall be submitted and approved for all materials and equipment prior to installation. If any material and/or equipment is installed prior to receipt by the Contractor of approved Shop Drawings, the Contractor is liable for its replacement at no additional cost to the Owner.
- H. Data submitted shall include information on all materials and equipment to demonstrate compliance with the Contract Drawings and Specifications. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.
- I. Any deviation of submitted material or equipment from the Contract Drawings or Specifications shall be clearly marked in red ink on Submittals, and itemized in a transmittal letter, in order to receive consideration for approval.
- J. Approval of material or equipment submittals containing deviations not specifically identified by Contractor shall not relieve the Contractor from compliance with specified requirements.
- K. All major items of mechanical equipment shall be the latest standard catalog products of reputable manufacturers. Where two (2) or more items of the same kind of equipment are required, they shall be the products of a single manufacturer.

- L. Thoroughly review and stamp all submittals to indicate compliance with Contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.
- M. Submittals will be reviewed for general compliance with design concept in accordance with Contract Documents, but dimensions, quantities, or other details will not be verified.
- N. Increase, by the quantity listed below, the number of electrical related Shop Drawings, product data, and samples submitted, to allow for required distribution plus two copies of each submittal required, which will be retained by the Electrical Consulting Engineer.
  - 1. Shop Drawings Initial Submittal: 1 additional blue- or black-line print.
  - 2. Shop Drawings Final Submittal: 1 additional blue- or black-line print.
  - 3. Product Data: 1 additional copy of each item.
- O. Additional copies may be required by individual sections of these Specifications.
- P. Shop Drawings:
  - 1. Prepare and submit SHOP DRAWINGS AND/OR DIAGRAMS for all specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on the contract drawings.
  - 2. Shop drawings shall include plans, elevations, sections, mounting details of component parts, point to point interconnection diagrams, elementary diagrams, single line diagrams, and any other drawings necessary to show the fabrication and connection of the complete item or system.
  - 3. Shop drawings shall be provided for, but not limited to the following items: Analysis and Coordination Study Automatic Transfer Switches Ballasts **Basic Electrical Materials** Cable - 600 volt Cable Trav **Circuit Breakers** Conduit and Surface Raceway Contractor and Subcontractor Qualifications **Controllers & Control Devices** Disconnects **Electrical Connection Coordination Schedule** Engine/Generator **Equipment Connections Equipment Pads** Excavation and Backfill **Fire Alarm Systems** Firestopping Fuses Ground Conductors, Rods Identification System Innerduct Lamps Lighting Control Equipment Lighting Fixtures Lightning Protection System Low Voltage Fuses Material and Equipment List

GAI#17092

- Motor Starters **Occupancy Sensors** Outlet Boxes Panelboards Receptacles **Record and Information Booklet** Safety Switches Schedule of Values Sleeves, Hangers, Supports Sound Systems Submittal Schedule Surge Suppression Devices Switchboards Tests and Reports Transformers Underground Cable Wiring Devices Wiring Diagrams
- Q. The Contractor, additionally, shall submit for approval any other shop drawings as required by the Architect. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.
- R. The Contractor shall prepare and submit a Detail Schedule of Values indicating the Contract costs for the major work items. The Contractor shall provide additional detail and information as requested by the Engineer.
- S. The Contractor shall prepare and submit a complete Submittal Schedule. The Schedule shall include a listing of all Submittals, Shop Drawings, and Coordination Drawings.

# 2.4 COORDINATION DRAWINGS:

- A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of the work. Drawings shall include, but not be limited to the following:
  - 1. Telecommunication Rooms indicating data rack assemblies, panels, etc.
  - 2. Electrical Rooms indicating switchboard assemblies, transformers, equipment pads, panels, etc.
  - 3. Mechanical Equipment Rooms, including panels, transformers, starters, equipment, etc.
- B. Draw plans to a scale not less than 1/4 inch equals one foot. Include plans of the proposed work, showing all equipment, major elements, conduit, and wiring in the areas involved. Fully dimension all work, horizontally and vertically. Show coordination with other work including piping, ductwork and other mechanical work, walls, doors, ceilings, columns, beams, joists, and other architectural and structural work.
- C. Identify all equipment and devices on wiring diagrams. Where field connections are shown to factory-wired terminals, furnish manufacturer's literature showing internal wiring.
- D. Prepare, submit, and use scaled layout drawings indicating dimensions, clearances, and actual equipment dimensions. Layout drawing shall include, but not be limited to the following:
  - 1. Pad-mounted equipment and equipment connections.

2. Underground conduits, ductbanks, manholes, handholes, and building penetrations.

#### 2.5 RECORD DRAWINGS:

- A. As the work progresses, record on a set of white prints the installed locations, sizes of electric feeders, equipment, etc. Upon completion of the work, submit one (1) complete set of white prints with "As-Built" information neatly recorded thereon in <u>red ink</u>. Use other colors to distinguish between variations in separate categories of the work. Note related change-order numbers where applicable. Provide electronic copies to the owner and architect at the completion of the project.
- B. Write step-by-step detailed instructions for turn-on, turn-off, seasonal changeover, and periodic checks of all systems and equipment. Include all precautions and warnings.
- C. Prepare a list of the manufacturers of all major equipment, their local service representative and procedures for obtaining service.
- D. Post one (1) copy of all instructions, lists, charts, and diagrams at the equipment or where indicated, mounted under glass or approved plastic cover.
- E. Furnish to the Owner two (2) copies of the Manufacturer's installation and operations instructions, and an electronic copy. Include replacement parts lists where applicable. Also include copies of all posted instructions, lists and charts. Assemble the material in one or more heavy duty 8- 1/2" x 11" loose leaf binders with tab separators. Submit for approval before final delivery. Binder shall be labeled on spine and on cover with Project Name.
- F. Deliver all instruction materials to the Owner prior to the formal instruction period.
- G. Deliver two (2) complete sets of all approved submittals to the Owner for filing, including electronic copies.
- H. Prepare record documents in accordance with the requirements in the specifications. In addition to the requirements specified, indicate installed conditions for:
  - 1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and circuit breaker size and arrangements.
  - 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
  - 3. Approved Substitutions, Contract Modifications, and actual equipment and materials installed.
- I. The Contractor shall keep at the site at all times during construction, one set of up-to-date Contract prints for the express purpose of showing any and all changes made during construction. The Contractor shall make the prints showing each change and shall incorporate all changes in "Record/As-Built Drawings" to be submitted to the Engineer upon completion of the project.
- J. The Contractor shall show proof of up-to-date record drawings to the Owner prior to submitting monthly invoice.
- K. The Contractor shall conform to all drawings, including all revisions, addendums, alternates, change orders, deletions, existing conditions, and as-built conditions without extra cost to the Owner.

#### 2.6 DEMONSTRATION AND OPERATING INSTRUCTIONS

- A. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project. The Contractor shall provide a minimum of three 2-hour sessions of system demonstration and operation for each system including, but not limited to: lighting controls, switchboards, generator, transfer switches.
- B. Where specified in technical sections, provide longer periods required for specialized equipment.
- C. Contractor shall provide start-up of all systems in an orderly, organized, and coordinated manner to ensure that all systems are functioning as designed. The Contractor shall provide a detailed start-up, testing, and demonstration plan for all systems in a coordinated manner that is documented in writing at least 45 days prior to system start-up. Start-up, testing and demonstration plans shall include detailed point-by-point checklists that clearly show that systems are, in fact, functioning as designed. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of systems and equipment.
- D. The Operating and Maintenance Manual shall be available at the time of the instructions, for use by Instructors and Owner personnel.
- E. Videotape each instruction session, including both the sessions specified above and added sessions required in technical sections for specialized equipment. Provide one complete set of DVD video disks with each Operating and Maintenance Manual.
- F. Schedule the general and specialized instruction periods for a time agreed upon by he Owner and Engineer. All operation training and demonstrations shall be complete prior to Owner acceptance of any given system.

#### PART 3 - EXECUTION

#### 3.1 EXAMINATION OF SITE, SURVEYS, AND MEASUREMENTS:

- A. Examine the site, determine all conditions and circumstances under which the work must be performed, and make all necessary allowances for same. No additional cost to the Owner shall be permitted for Contractor's failure to do so.
- B. Examine the site and observe the conditions under which the work will be done or other circumstances which will affect the contemplated work. No allowance will be made subsequently in this connection for any error or negligence on the Contractor's part.
- C. The Contractor shall base all measurements, both horizontal and vertical, from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.
- D. Any discovery of discrepancy between actual measurements and those indicated which prevents following good practice or the intent of the Drawings and Specifications shall be brought to the attention of the Owner's Representative. Work shall not proceed until receiving instructions from the Owner's Representative.
- E. The Contractor shall follow Drawings in laying out the work and check Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, the Owner's Representative shall be notified before proceeding with the installation.

- F. To prevent conflict with the work of other trades and for proper execution of the work, the Contractor, as directed by the Owner's Representative, shall make the necessary modifications in the layout as needed, at no extra charge to the Owner.
- G. The Contractor shall be solely responsible for the proper arrangement of his conduit and equipment.
- H. The Engineer shall make all final decisions as to any conditions that require the changing of any work.
- I. The Contractor shall have competent supervision on the site at all times to lay out, check, coordinate, and supervise the installation of all electrical work and be responsible for the accuracy thereof. He shall plan the installation of all electrical work, giving consideration to the work of other trades, to prevent interference.
- J. The Contractor shall determine the location, size, etc., of all chases, sleeve openings, etc., required for the proper installation of the electrical work and see that such are provided. All chases, sleeves, openings, etc., shall be set prior to erection of new work to prevent delay in the progress of other work or trades.
- K. Conditions and/or situations that prevent the proper installation of any equipment or item where shown on the Drawings shall be called to the attention of the Engineer for instructions.
- L. The Contractor shall have equipment shipped or fabricated in sections of suitable size for entering the building and being removed from the finished building in the future, if necessary.
- M. The Contractor shall fully investigate all peculiarities and space limitations for all materials and equipment.
- N. Outlet, pull, and junction boxes and other appliances that require operation, examination, adjustment, servicing or maintenance shall be readily accessible.
- O. The Contractor shall take all field measurements necessary for this work and shall assume responsibility for their accuracy.
- P. The Contractor shall coordinate the electrical work with all other sub-contractors. All work shall be so arranged that there will be no delay in the proper installation and completion of any part or parts of electrical equipment. All electrical work shall be installed in proper sequence with other trades without any unnecessary delay.
- Q. The Drawings are to some extent diagrammatic and indicate the general arrangement of the equipment, the runs of conduit, and the manner of connection.
- R. The Contractor shall confer with all sub-contractors engaged in the construction of the project, regarding the work that may, in any way, affect his installation. Whenever interference occurs, before installing any of the work in question, the Contractor shall consult with all sub-contractors and shall come to an agreement with them as to the exact location and level of his conduit parts of his equipment.
- S. The Contractor shall be responsible for determining exact property lines and area of work. The Contractor shall not install any equipment or conduits outside of the property lines and/or area of work without written direction from the Owner. Any work indicated diagrammatically on the Contract Documents to be installed beyond the property lines and/or area of work shall be verified with the Owner prior to installation.

#### 3.2 GENERAL RESPONSIBILITIES:

- A. The Contractor shall be responsible for systems and related damages possible, and shall hold harmless the Owner, the Architect and his consultants from malfunction of systems and equipment installed under this Contract as defined in the laws of the State of Maryland pertaining to real property for the period of time as defined by such laws.
- B. It is the intent of these Specifications to fully cover without exception all required labor and materials so that the finished work will be delivered to the Owner in a complete and satisfactory working installation. Excavation, wiring, distribution, etc., shall be performed in compliance with the Contract Documents.
- C. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Owner.
- D. Conflicting points in the Specifications or on the Drawings shall be called to the attention of the Architect prior to the execution of the Contract.

# 3.3 STORAGE AND PROTECTION OF EQUIPMENT

- A. <u>All</u> electrical equipment to be used in the construction shall be properly stored and protected against the elements. All equipment shall be stored under cover, and shall not be stored at the construction site on the ground, in mud, water, snow, rain, sleet or dust. Large diameter cables may be stored on reels with weatherproof materials. Such weatherproof materials shall be heavy-duty, securely fastened and made impervious to the elements.
- B. Conventional electrical construction materials such as building wire, outlet and junction boxes, wiring devices, conduit, lighting fixtures, fittings, etc., shall be stored in construction buildings, covered trailers or portable covered warehouses. Any equipment subject to damage or corrosion from excessive moisture shall be stored in dry, heated areas. Any equipment containing plastic or material subject to damage caused by excessive heat or sunlight shall be stored to prevent such damage. This includes plastic ducts and lenses.
- C. Switchboard, motor controllers, panelboards, breakers, emergency lighting, and supervisory equipment, if delivered to the construction site before the building is under cover, shall be warehoused and protected as follows: All gear and equipment shall be covered and protected from the elements and other damage and shall be stored in a clean, dry, heated atmosphere, under cover.
- D. All gear and equipment delivered to the construction site after the building is under cover shall be protected as described above and in addition shall be provided with auxiliary heat to prevent condensation damage. The gear shall also be protected against damage caused by installation of any building systems and equipment; or damage caused by carelessness of workmen who are installing equipment connected to or adjacent to the above electrical equipment.
- E. Equipment damaged as a result of the above conditions shall be properly repaired at the Contractor's expense or shall be replaced at the Contractor's expense, if, in the opinion of the Engineer the equipment has been damaged to such an extent it cannot operate properly after repairs are made.
- F. All electrical enclosures exposed to construction damages such as paint spots, spackling or plaster spatter, grout splashes, waterproofing compound, tar spots or runs and pipe covering compound splashes, shall be completely covered and protected against damage.

- G. In the event leakage into the building of any foreign material or fluid occurs or may occur, the Contractor shall take all steps as described above to protect any and all equipment.
- H. After connections to electrical equipment are complete and the equipment is ready for operation, all construction debris shall be removed from all enclosures. Such debris includes dust, dirt, wire clippings, tape and insulation removed in order to make the connection.

# 3.4 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
  - 1. Coordinate electrical systems, equipment, materials, and installation with landscape/irrigation contractor(s).
  - 2. Verify all dimensions by field measurements.
  - 3. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
  - 4. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components where installed exposed in finished spaces.
  - 5. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. All equipment and disconnects shall maintain proper working space to conform to NEC.
  - 6. Install systems, materials, and equipment giving right-of-way priority to systems that require installation at a specified slope.
  - 7. Arrange for chases, slots and openings in other building components during progress of construction, to allow for electrical installation.
  - 8. Space, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work.

#### 3.5 SUPERVISION AND COORDINATION:

- A. Provide complete supervision, direction, scheduling and coordination of all work under the contract, including that of subcontractors, using full attention and the best skill. Be responsible for all work and make all subcontractors, suppliers and manufacturers fully aware of all requirements of the contract.
- B. Coordinate the rough-in of all work performed under Mechanical & Electrical Divisions.
- C. The Contractor shall coordinate all electrical rough-ins with approved shop drawings and coordination drawings. Any rough-in installed without complete coordination shall be at the Contractor's risk and expense.
- D. Coordinate the installation of all necessary rough-in of work, sleeves, anchors and supports for conduit, wiring, and other work performed under Divisions Mechanical and Electrical Divisions.
- E. Coordinate the spacing and arrangement of lighting fixtures, diffusers, grilles and access panels in ceilings to establish a symmetrical pattern.
- F. Where a discrepancy exists within the Specifications or drawings or between the Specifications and Drawings, the more stringent (or costly) requirement shall apply until a clarification can be

obtained from the Engineer. Failure to clarify such discrepancies with the Engineer will not relieve the Contractor of the responsibility of conforming to the requirements of the Contract.

- G. Failure of the Contractor to obtain a full and complete set of Contract Documents (either before or after bidding) will not relieve the Contractor of the responsibility of complying with the intent of the Contract Documents.
- H. To insure proper electrical coordination between the electrical components supplied under the Electrical Divisions and the equipment supplied under the Mechanical Divisions, a schedule shall be submitted, prior to start of work, for review by the Engineer with the following column headings:

1.Equip or	2. HP or KVA	3.Voltage and Phase	4. Power Factor	5. Capacitor	6.Motor Starter	7.Discon.	8.Controls	9.Remark s
Item								

Description of Column Headings:

- 1. List all the approved equipment furnished under Mechanical Division that requires electrical connections and designate the equipment as it appears in the Mechanical Divisions. Indicate the quantity, if more than one, in parentheses of identical equipment being supplied.
- 2. Indicate the supplied horsepower of the equipment listed under Column No. 1. If equipment listed has more than one motor, indicate each motor and its respective horsepower. Indicate the kVA rating for all other equipment requiring an electrical connection, unless the electrical connection is for a control circuit only.
- 3. Indicate the voltage and phase requirements for equipment listed under Column No. 1. If more than one electrical circuit or voltage is required for the listed equipment, it shall be so indicated. Indicate wiring required for connection, including all phase, neutral, and ground conductors.
- 4. Indicate the power factor rating for all motors listed under Column No. 2.
- 5. Where a capacitor is to be provided, indicate specification it is supplied under and indicate the KVAR size for any capacitor provided under Division 26.
- 6. Where a motor starter is required, indicate the specification division it is supplied under and the type of motor starter; across-the-line, reversible, variable speed, two speed-single winding, etc. Indicate In Column No. 9 if the motor starter provided under Division 26 is not compatible with the motor specified.
- 7. Where a disconnect switch is required by the National Electric Code or by the contract documents for the equipment listed under Column No. 1, indicate under which Division the disconnect switch is supplied.
- 8. Indicate the Division under which the controls for the equipment listed under Column No. 1 are provided.
- 9. Indicate any discrepancies between what is indicated in the contract documents and what is actually being provided.
- I. The Contractor shall fully coordinate the electrical connections to all equipment prior to installations, with the approved Shop Drawings and the trades involved. Coordination shall include voltage, phases, quantity and size of wiring, device sizes, terminations, rough-in work, and other coordination for a complete installation.
- J. Coordinate Division 26 work with all trades.
- K. Install work with proper clearances and access. Carefully examine all contract drawings and fit the work in each location without substantial alteration. Where departures are proposed or required, submit detailed drawings for acceptance. The right is reserved to make reasonable changes in location of equipment, conduit and wiring up to the time of rough-in or fabrication.

- L. Coordinate light switch locations with door swings prior to rough-in. No switches permitted behind doors.
- M. Coordinate electrical work with architectural items and equipment. Typical equipment refers to, but is not limited to, the following:
  - 1. Countertops, Casework and Cabinets.
  - 2. Fume and Exhaust Hoods.
  - 3. Kitchen equipment.
  - 4. Do not install outlets, switches, etc., behind casework, cabinets, etc.
  - 5. Data, phone, and other low voltage system outlets shall be mounted above the counter tops to match power outlets in the same areas.
  - 6. Coordinate counter top outlets with drilling of casework/counters.
  - 7. Coordinate surface raceways and outlets above and below counters with approved casework shop drawings to avoid conflicts with sinks and other appurtenances.
  - 8. Verify lab/kitchen equipment nameplates and connection requirements prior to rough-in.
  - 9. Shop equipment connections, including busways.
- N. This Contractor shall make all system connections required to equipment furnished and installed under other divisions. Connections shall be complete in all respects to render this equipment functional to its fullest intent. The Contractor shall make all system connections required to equipment furnished under other Divisions. Circuits shall be extended to all equipment which is incidental to, but not necessarily shown, for equipment specified under other divisions such as magnetic flow meters, ATC panels, liquid level controls, leak detection systems, etc. Connections shall be complete in all respects to render this equipment functional to its fullest extent.
- O. It shall be the responsibility of the Contractor to obtain complete instructions for connections.

#### 3.6 GUARANTEE:

- A. Guarantee obligations shall be as hereinbefore specified in the GENERAL AND SPECIAL CONDITIONS of these specifications, except as follows:
  - 1. Guarantee the complete electrical system free from all mechanical and electrical defects for the period of two (2) years beginning from the day of final acceptance of the work by the Owner.
  - 2. Also, during the guarantee period, be responsible for the proper adjustments of all systems, equipment and apparatus installed by the Contractor and do all work necessary to ensure efficient and proper functioning of the systems and equipment.
  - 3. Upon receipt of notice from the Owner of failure of any part of the electrical installation during the guarantee period, new replacement parts shall be furnished and installed promptly at no cost.
  - 4. Warranty From the Manufacturer: Contractor shall obtain all warranty papers and records from the Original Equipment Manufacturer according to their warranty policy and deliver the same to the Owner. Contractor shall fulfill all the Original Manufacturer's requirements to validate the warranty as offered by the Original Equipment Manufacturer.
- B. Provide 24-hour service for any and all warranty problems experience in the operation of the equipment provided.
- C. Any equipment or system in need of warranty work whether during regular hours or on an emergency basis, shall be immediately serviced and repaired. The warranty work and guarantee shall include all parts and labor and shall be furnished at no cost to the Owner.

- D. The Contractor shall guarantee to make good any and all defects in his work, exclusive of lamps, which may develop due to defective workmanship or materials, within one year from the date of final acceptance of the work by the Owner.
- E. In addition to the warranty and correction of work obligations contained in the General and supplementary Conditions, correct the work of the system as embraced by the Specification, free from Mechanical and Electrical defects for the warranty period beginning from the day of acceptance of the building by the Architect for the beneficial use of the Owner.
- F. During the warranty period, take responsibility for the proper adjustments of systems, equipment and apparatus installed and perform work necessary to ensure the efficient and proper functioning of the systems and equipment.
- G. Certain items of equipment hereinafter specified shall be guaranteed for a longer time than the general warranty period. These guarantees shall be strictly adhered to and the Contractor shall be responsible for service or replacement required in connection with guarantee of these items. These guarantees shall commence on the same date as the final acceptance by the Architect.
- H. Submission of a bid proposal for this Project warrants that the Contractor has reviewed the Contract Documents and has found them free from ambiguities and sufficient for the construction and proper operation of systems installed for this project. If discrepancies are found, have them clarified by Addendum.
- I. It is possible that certain areas of the building or certain systems will be accepted at a time different than as specified. The date of acceptance by the Architect for beneficial use of the Owner for these building areas or systems will be adjusted accordingly.

# 3.7 SCHEDULING OF WORK:

- A. The Contractor shall not be permitted to do any work in any area of any occupied building during normal hours, except in areas specifically assigned.
- B. Coordination of work by the Contractor is essential such that power outages are kept to a minimum in quantity and duration. All required outages shall be approved by the Owner for optimum time scheduling. Written notice of not less than 15 calendar days shall precede all power outages.

#### 3.8 TEMPORARY FACILITIES:

- A. General: Refer to the Division 1 Sections for general requirements on temporary facilities.
- B. Description: Furnish and install the necessary metering and distribution equipment or an adequate, 3-phase, 4 wire temporary service and all temporary wiring, including step-down or step-up dry-type transformers. Exact requirements for temporary service will be determined by the Contractor.
- C. The Contractor's attention is directed to the Occupational Safety and Health Act, Americans with Disabilities Act and NEC requirements for electrical work on construction sites.
- D. Materials: Lights at each floor in each stair. At least one light outlet per 1200 square feet on each floor, exclusive of stairs.
  - 1. One 20-ampere circuit for each 7500 square feet of gross floor area per floor to which various trades may attach their cords.

- 2. One temporary 220v power online in corridor (each elevator lobby) including connections to saws, fireproofing equipment and wood sanding equipment, if required.
- 3. Power for testing and operating of elevators.
- 4. Temporary lighting for stripping forms for all floors below grade.
- 5. Power for crane operation.

E. Installation: Temporary lighting shall provide minimum foot candle levels for construction as follows:

AREA	FOOT CANDLE LEVEL
General construction area lighting, corridors, hallways and exit ways.	10
Electrical equipment rooms, active storerooms, shops, locker and dressing areas	10

- F. The Contractor shall pay for all material and labor to provide and maintain temporary service.
- G. The Contractor shall obtain and pay for temporary electrical service for construction power.
- H. Provide all underground and/or overhead equipment, transformers, overcurrent devices, wires, connections, etc., for obtaining power from utility company lines.
- I. Remove all temporary power installations and connections after permanent power is established and/or prior to completion of the project.

#### 3.9 DEMONSTRATION:

- A. As a part of this contract, the Contractor shall provide for the services of equipment manufacturers or their established representatives to demonstrate to selected maintenance personnel the correct operation, safety and maintenance of all electrical equipment under this contract.
- 3.10 PAINTING AND FINISHES:
  - A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc., shall be galvanized or stainless steel.
  - B. Clean surfaces prior to application of coatings, paint, or other finishes.
  - C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pre-treatment.
  - D. Protect all finishes and restore any finishes damaged as a result of work under Division 26 to their original condition.
  - E. The preceding requirements apply to all work, whether exposed or concealed.
  - F. Remove all construction marking and writing from exposed equipment, conduit, and building surfaces. Do not paint manufacturer's labels or tags.

- G. All exposed conduit, etc., shall be painted, except in electrical rooms, mechanical rooms, storage rooms, and crawl spaces. Colors shall be selected by the Architect and conform to ANSI Standards.
- H. Submit color of factory-finished equipment for approval prior to ordering.

# 3.11 PROTECTION OF WORK:

- A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.
- B. Cover temporary openings in conduit and equipment to prevent the entrance of water, dirt, debris, or other foreign matter.
- C. Cover or otherwise protect all finishes.
- D. Replace damaged materials, devices, finishes and equipment.

# 3.12 OPERATION OF EQUIPMENT:

- A. Clean all systems and equipment prior to initial operation for testing, retesting, or other purposes. Set, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.
- B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment.
- C. Do not use electrical systems for temporary services during construction unless authorized in writing by the Owner. Where such authorization is granted, temporary use of equipment shall in <u>no way</u> limit or otherwise affect warranties or guaranty period of the work.
- D. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items such as filters.

# 3.13 TESTING AND ADJUSTMENT

- A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.
- B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.
- C. On all circuits, 600 volts or less, provide circuits that are free from ground faults, short circuits and open circuits.
- D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.
- 3.14 IDENTIFICATIONS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS:

- A. Contractor shall submit for approval schematic diagrams of each electrical system installed in the building. Diagrams shall indicate device location, service, type, make, model number and the identification number of each device in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under glass and hung in each Main Equipment Room where directed. Contractor shall deliver the tracing or sepia from which the diagrams were reproduced to the Owner.
- B. All equipment shall be plainly tagged.
- C. All items of equipment, including motor starters, panels, etc., shall be furnished with white letters and numbers on black plastic identification plates or aluminum letters and numbers on black engraved aluminum identification plates. Lettering shall be a minimum of 1/4" high. Identification plates shall be securely affixed to each piece of equipment, starters, panels, etc., by screws or adhesive (Tuff-Bond #TB2 or as approved equal). Pressure sensitive tape backing is prohibited.
- D. Provide three (3) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the "Record and Information Booklet" as hereinafter specified.
- E. Provide at least 24 hours of straight time instruction to the operating personnel. This instruction period shall consist of not less than three (3) consecutive 8-hour days. Time of instruction shall be designated by the Owner. Provide two VHS video taped copies of all instructional periods/demonstrations.

# 3.15 RECORD DRAWINGS AND SPECIFICATIONS:

- A. Upon completion of the Electrical installations, the Contractor shall deliver to the Engineer one complete set of prints of the Electrical Contract Drawings which shall be legibly marked in red pencil to show all Addenda, approved Shop Drawings, Change Orders, changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings. Provide electronic copies of each.
- B. The Contractor shall provide a record specification including all Addenda and other modifications. Record substantial variations in actual work performed. Identify all substitutions.

#### 3.16 RECORD AND INFORMATION BOOKLET:

- A. The Contractor shall have prepared three (3) copies of the Record and Information Booklet as well as an electronic copy and deliver these copies of the booklet to the Owner. The booklet shall be as specified herein. The booklet must be approved and will not be accepted as final until so stamped.
- B. The booklet shall be bound in a three-ring loose-leaf binder similar to "National" No. 3881 with the following title lettered on the front and on the spine of the binder: "Record and Information Booklet (insert name of the project)". No sheets larger than 8-1/2" x 11" shall be used, except sheets that may be neatly folded to 8-1/2" x 11" and used as a pull-out. An Index will include the section tabs for each subject included. If more than one binder is required, print covers and spines with Volume numbers. Include in the front of every binder an index to all binders.
  - 1. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
  - 2. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, typed on white paper.
  - 3. Part 1: Directory, listing names, addresses, and telephone numbers of Electrical Engineers; Contractor; Electrical Subcontractors; and major Electrical equipment

suppliers. Provide sales and service representative names and phone numbers of all equipment.

- 4. Part 2: Operation and Maintenance Instructions, arranged by Specification Section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
  - a. Significant design criteria.
  - b. List of equipment. Complete record of material list. Catalog brochures and product data for all components. Include all submittal comments, and corrected catalog data and shop drawings on each piece of equipment and each system.
  - c. Parts list for each component, including recommended spare parts list. Include motor starter overload schedules.
  - d. Operating instructions, including sequence of operation.
    - 1) Description of function, normal operating characteristics and limitations, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts. Provide a description of each system installed.
    - 2) Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; control, stopping.
  - e. Maintenance instructions for equipment and systems. Detailed checkout procedures to insure operation of systems and gear, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
  - f. Servicing, diagnostic and troubleshooting instructions and procedures for systems and major equipment.
  - g. Recommended preventative maintenance program, including a list of items requiring inspection and servicing. Provide Chart Form indicating time and type of routine and preventative maintenance of electrical equipment, etc. The chart shall also indicate tag number, model number of equipment, location and service.
    - 1) For replacement items, indicate type, size and quantity of the replaceable items.
    - 2) Provide lubrication schedule, including type, grade, temperature range and frequency.
    - 3) Provide a list of each type of lighting fixture lamp used, lamp fixture used, and source.
    - 4) Include estimated mean time between failures for major parts.
  - h. Wiring Diagrams, Block Diagrams, and Assembly Drawings.
  - i. Panelboard Circuit Directory for each panelboard, including Panel Name, Panel Location, Panel Ratings, spare circuit breakers, spaces for additional circuit breakers.
  - j. List of equipment keys turned over to the Owner.
- 5. Part 3: Project Documents and Certificates, including the following:
  - a. Shop Drawings and Product Data. Record Documents of the systems.
  - b. Photocopies of certificates.
  - c. Photocopies of Manufacturers' and Contractors' warranties, guarantees.
  - d. Test Reports: Copies of the approved results of all tests required under all sections of specifications.
  - e. Inspection Certificates.
  - f. Manufacturer's Conformance Certificates.
- 6. Provide one copy (DVD video disk) of video instruction session with each booklet set. Label video disk with all pertinent information.
- 7. Submit one copy of completed volumes in final form 15 days prior to final Inspection. This copy will be returned with Engineer comments. Revise content of documents as required prior to final submittal.
- 8. Submit final volumes revised, within ten days after final inspection.
- C. Upon completion of the project, the Contractor shall furnish the Owner a complete list of suppliers of equipment for parts and maintenance purposes. The list shall include the name, address, and telephone number of the parts and maintenance firm on a single 8-1/2" x 11" sheet of paper.
- D. This item shall include the furnishing of a complete list of equipment installed on the project, including the Manufacturer's name, the make and model number of the equipment, and address and telephone number of the nearest supplier who stocks maintenance and/or replacement parts. The list should be submitted along with as-built drawings and be typed in an organized manner.

### 3.18 INSTALLATION AND COORDINATION DRAWINGS:

- A. In congested areas, prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following: Complete Electrical Drawings showing coordination with lights, electrical equipment, mechanical, plumbing, HVAC, structural, and architectural elements and provision for access.
- B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment and conduit in areas involved. Fully dimension all work including lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists, mechanical equipment, and other architectural and structural work.
- C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.

### END OF SECTION 260501

# **SECTION 260519**

# LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Building wires and cables rated 600 V and less.
  - 2. Connectors, splices, and terminations rated 600 V and less.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

#### 1.4 QUALITY ASSURANCE

- A. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.
- B. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements. Procedures: Perform each visual and mechanical inspection and electrical test state din NETA ATS Section 7.3.1. Certify compliance with test parameters.
- C. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.
- D. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- E. Verify continuity of each branch circuit conductor.
- F. Tests: Service Entrance Cables, Power & Lighting Distribution Feeders and Feeders to all major mechanical equipment at 60A and over (i.e., chillers, AHU's, etc.).

- 1. Tests shall be performed with a 1000-volt megger, and conductors shall test free from short-circuits and grounds.
- 2. Conductors shall be tested phase-to-phase and phase-to-ground.
- 3. Furnish the instruments, materials, and labor required. Perform the tests in the presence of the Contracting Officer.
- 4. Test readings shall be recorded and delivered to Owner and Engineer in a report.
- 5. Copy of Test results shall be included in O&M Manuals.
- G. Demonstration: Subsequent to wire and cable hook-ups, energize circuit and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

# PART 2 - PRODUCTS

## 2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work are the following:
  - 1. Wires and Cables:
    - a. American Insulated Wire Corp.; Leviton Manufacturing Co.
    - b. BICC Brand-Rex Company.
    - c. Carol Cable Co., Inc.
    - d. Senator Wire & Cable Company.
    - e. Southwire Company.
  - 2. Connectors and Accessories for Wires and Cables:
    - a. AMP Incorporated.
    - b. Buchanan.
    - c. General Signal; O-Z/Gedney Unit.
    - d. Monogram Company; AFAC.
    - e. NSI Industries, Inc.
    - f. Square D Company; Anderson.
    - g. 3M Company; Electrical Products Division.
- B. Copper and Aluminum Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW, USE, and SO.
- D. Multiconductor Cable: Comply with NEMA WC 70 for metal clad cable, Type MC and Type SO with ground wire.

### 2.2 CONNECTORS AND SPLICES

- A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications" Article.
- B. Split Bolt Connectors: Not Acceptable.

- C. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.
- D. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.
- E. All wire connectors used in underground or exterior pull boxes shall be gel-filled twist connectors or a connector designed for damp and wet locations.
- F. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.
- G. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic high conductivity copper tubing, internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.
- H. Heat shrinkable tubing shall meet the requirements of ANSI C119.1-1986 for buried connections to 90°C and shall be material flame-retarded per IEEE 383 "Vertical Tray Flame Test". Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances.
- I. Wire Nut Connectors:
  - 1. Wire nuts install in wet locations, exterior, etc., shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air.
  - 2. Connectors shall be UL listed appropriately sized according to manufacturer's recommendation for the suitable wire sizes and voltage rating (600 volt minimum).
  - 3. Connectors body shall have a color-coded outer shell.
  - 4. Connectors shall be as manufactured by King Technology or approved equal.
- PART 3 EXECUTION
- 3.1 CONDUCTOR MATERIAL APPLICATIONS
  - A. Feeders: Soft Drawn Copper, 98% conductivity minimum, solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Aluminum STABILOY for conductors indicated on the drawings.
  - B. Branch Circuits: Soft Drawn Copper. 98% Conductivity minimum, Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS
  - A. 600 volt, unless otherwise noted, #12 AWG minimum (except control cable may be #14 AWG).
  - B. Service Entrance: Type THHN-THWN, single conductors in raceway.
  - C. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

- D. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.
- E. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Metal-clad cable, Type MC, except branch circuits from the panelboard to the first Home run fed on the circuit shall be type THHN-THWN, single conductors in raceway.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainlesssteel, wire-mesh, strain relief device at terminations to suit application.
- J. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- K. Class 2 Control Circuits: Type THHN-THWN, in raceway.
- L. Conductors shall be rated 75 deg C in wet locations and 90 deg C in dry locations.

# 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Section 260429, "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Section 260553, "Identification for Electrical Systems."

# 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torquetightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

- C. Wiring at Outlets: Install conductor at each outlet, with at least 8 inches (200 mm) of slack.
- D. Wiring for general 15 and 20 amp 120 volt and 277 volt branch circuit work shall be as follows unless otherwise indicated:

HOME RUN LENGTH AND WIRE SIZE				CIRCUIT LENGTH AND WIRE SIZE			
120 Volt		277 Volt		120 Volt		277 Volt	
0 – 60'	#12	0 – 175'	#12	0 – 100'	#12	0 – 200'	#12
60 – 100'	#10	175 – 350'	#10	100' & Up	#10	200' & Up	#10
100' & Up	#8	350' & Up	#8				

Circuit length as given above shall be the wire length between the first and last outlet on the circuit. Home run length as given above shall be the wire length between the first outlet and the panelboard. In accordance with the above, where the size of branch circuit conductors is increased by the minimum required by the NEC for the branch circuit rating, it is the Contractor's responsibility to insure that the termination provisions of all equipment connected to such circuits are listed as suitable for the conductor sizes involved.

- E. Joints of #10 AWG and smaller shall be made with properly insulated solderless type pressure connectors. Where stranded conductors or multiple solid conductors are connected to terminals, solderless lugs manufactured by Thomas and Betts Company or equivalent shall be used.
- F. Joints of #8 AWG and larger in power and lighting circuits shall be of the type indented into the conductor by means of a hand or hydraulic pressure tool. Connectors shall be Burndy "Hy-dent', T&B "St-Kon", or equivalent. Connectors for control wiring shall be Burndy "Hy-Lug", or equivalent.
- G. All circuits for exterior electric work shall be #10 AWG (minimum) and contain an extra #10 AWG (minimum) copper ground conductor. All exterior wiring shall be installed in conduit as specified above, unless otherwise noted as larger on the Drawings.

### 3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 26 Section "Firestopping." and "Basic Electrical Materials and Methods".

## 3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations according to Division 26 Section, "Basic Electrical Materials and Methods".

### 3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 7 Section "Through Penetration Firestop System."

## 3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.
- B. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements. Procedures: Perform each visual and mechanical inspection and electrical test state din NETA ATS Section 7.3.1. Certify compliance with test parameters.
- C. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.
- D. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- E. Verify continuity of each branch circuit conductor.
- F. Tests: Service Entrance Cables, Power & Lighting Distribution Feeders and Feeders to all major mechanical equipment at 60A and over (i.e., chillers, AHU's, etc.).
  - 1. Tests shall be performed with a 1000-volt megger, and conductors shall test free from short-circuits and grounds.
  - 2. Conductors shall be tested phase-to-phase and phase-to-ground.
  - 3. Furnish the instruments, materials, and labor required. Perform the tests in the presence of the Contracting Officer.
  - 4. Test readings shall be recorded and delivered to Owner and Engineer in a report.
  - 5. Copy of Test results shall be included in O&M Manuals.
- G. Demonstration: Subsequent to wire and cable hook-ups, energize circuit and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

# END OF SECTION 260519

# **SECTION 260526**

# GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:
  - 1. Underground distribution grounding.
  - 2. Common ground bonding with lightning protection system.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
  - 1. Test wells.
  - 2. Ground rods.
  - 3. Ground rings.
  - 4. Grounding arrangements and connections for separately derived systems.
  - 5. Grounding for sensitive electronic equipment.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
  - 1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, grounding connections for separately derived systems based on NETA MTS.
    - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
    - b. Include recommended testing intervals.

### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

# PART 2 - PRODUCTS

# 2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.
  - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter, unless otherwise noted.
  - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor, unless otherwise noted.
  - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

### 2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
  - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

### 2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by10 feet (19 mm by 3 m) in diameter.

# PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum.
  - 1. Bury at least 24 inches (600 mm) below grade.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  - 1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
- D. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### 3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

### 3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits of the same type as the circuit conductors. Install in same conduit with circuit conductors.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
  - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-24-inch (6-by-50-by-600-mm) grounding bus.
  - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- E. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

### 3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Where ground lug and bonding conductors installed indoors exceed 3 feet in length, install in EMT conduit.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ductbanks," and shall be at least 12 inches (300 mm) deep, with cover.
  - 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush

with finished grade or floor. Provide all test wells with twist lock cover, Harger#GAW910 or approved equal.

- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

### 3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
  - 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and

their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

- B. Report measured ground resistances that exceed the following values:
  - 1. Power and Lighting Equipment or System: 10 ohms.
  - 2. Substations and Pad-Mounted Equipment: 5 ohms.
  - 3. Manhole Grounds: 10 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

# END OF SECTION 260526

# **SECTION 260529**

# HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
- B. Related Sections include the following:
  - 1. Metal Fabrications For requirements for miscellaneous metal items involved in supports and fastenings.
  - 2. Joint Sealants For requirements for firestopping at sleeves through walls and floors that are fire barriers.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

### 1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

### 1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- 1.7 COORDINATION
  - A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
  - B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

# PART 2 - PRODUCTS

# 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Manufacturers: Subject to compliance with requirements, provide slotted metal angle and U-channel systems by one of the following:
    - a. Thomas & Betts Corporation.
    - b. Alstrut.
    - c. Unistrut; Diversified Products
    - d. Power-Strut.
  - 2. Manufacturers: Subject to compliance with requirements, provide conduit sealing bushings and accessories by one of the following:
    - a. Bridgeport Fittings
    - b. GS Metals, Corporation
    - c. O-Z / Gedney
    - d. Raco, Inc.
  - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Hilti Inc.
      - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
  - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti Inc.
      - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.
  - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  - 6. Toggle Bolts: All-steel springhead type.
  - 7. Hanger Rods: Threaded steel.

# 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.
- C. Submit structural calculations for load and strength of each component and detailing of each assembly.

# PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

# 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  - 6. To Light Steel: Sheet metal screws.
  - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for sitefabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

#### 3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## END OF SECTION 260529

# **SECTION 260533**

# **RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
  - 1. Division 26 Section "Underground Ductbanks" for exterior ductbanks, manholes, and underground utility construction.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. LFNC: Liquidtight flexible nonmetallic conduit.
- F. RNC: Rigid nonmetallic conduit.

#### 1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Custom enclosures and cabinets.
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
  - 1. Structural members in the paths of conduit groups with common supports.

- 2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
- D. Source quality-control test reports.
- 1.5 QUALITY ASSURANCE
  - A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  - B. Comply with NFPA 70.

# PART 2 - PRODUCTS

# 2.1 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Alflex Inc.
  - 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - 5. Electri-Flex Co.
  - 6. Manhattan/CDT/Cole-Flex.
  - 7. Maverick Tube Corporation.
  - 8. O-Z Gedney; a unit of General Signal.
  - 9. Wheatland Tube Company.
  - 10. Steel City.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.
- D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- E. EMT: ANSI C80.3.
- F. FMC: Zinc-coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket.
- H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
  - 2. Fittings for EMT: Steel compression type.

- 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- I. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

# 2.2 NONMETALLIC CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - 3. Arnco Corporation.
  - 4. CANTEX Inc.
  - 5. CertainTeed Corp.; Pipe & Plastics Group.
  - 6. Condux International, Inc.
  - 7. ElecSYS, Inc.
  - 8. Electri-Flex Co.
  - 9. Lamson & Sessions; Carlon Electrical Products.
  - 10. Manhattan/CDT/Cole-Flex.
  - 11. RACO; a Hubbell Company.
  - 12. Thomas & Betts Corporation.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- C. LFNC: UL 1660.
- D. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.

# 2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2. EGS/Appleton Electric.
  - 3. Erickson Electrical Equipment Company.
  - 4. Hoffman.
  - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - 6. O-Z/Gedney; a unit of General Signal.
  - 7. RACO; a Hubbell Company.
  - 8. Robroy Industries, Inc.; Enclosure Division.
  - 9. Scott Fetzer Co.; Adalet Division.
  - 10. Spring City Electrical Manufacturing Company.
  - 11. Thomas & Betts Corporation.
  - 12. Walker Systems, Inc.; Wiremold Company (The).
  - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.
- F. Nonmetallic Floor Boxes: Nonadjustable, round.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- J. Cabinets:
  - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.

### PART 3 - EXECUTION

# 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
  - 1. Exposed Conduit: Rigid steel conduit.
  - 2. Concealed Conduit, Aboveground: Rigid steel conduit.
  - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried, unless otherwise noted.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: EMT, support 6' on center maximum for sizes over 2-inches.
  - 2. Exposed, Not Subject to Severe Physical Damage: EMT, support 6' on center maximum for sizes over 2-inches.
  - 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
  - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT, support 6' on center maximum for sizes over 2-inches.

- 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
- 6. Damp or Wet Locations: Rigid steel conduit.
- 7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.
- 8. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
- 9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- 10. Greenhouse: PVC coated rigid steel conduit.
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
  - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
  - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
  - 3. Fasten rigid steel conduit with threaded galvanized steel fittings, double locknuts, and insulated bushings. Insulated bushings shall be OZ Gedny Type B.
  - 4. Exterior rigid steel conduit box connections shall be made with a Meyers Hub fitting only. Meyers Hub fittings shall be Cooper Crouse-Hind type.
  - 5. All LB"s, C, and T condulets shall be constructed of malleable iron. No aluminum/die pot metal type permitted.

### 3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hotwater pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
  - 1. Where specifically noted on the Drawings.
  - 2. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab

support. Maximum conduit size shall be 1-1/4" without specific permission of structural engineer.

- 3. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- 4. Change from PVC to rigid steel conduit before rising above the floor.
- 5. Conduits in close proximity to each other shall be located and wrapped with wire mesh to prevent cracking of slab.
- I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where otherwise required by NFPA 70.
- M. Expansion-Deflection Fittings: Provide an expansion/deflection fitting in each concealed or exposed electrical run crossing a building expansion joint. Fittings shall be complete with bronze end couplings, neoprene sleeve, tinned copper braid integral bonding jumper and stainless steel bands. Expansion/deflection fittings shall be suitable for the size and type of conduit run they connect. Bonding jumper shall comply with NEC and UL requirements.
  - 1. Expansion/deflection fitting shall accommodate the following movements without collapsing or fracturing the conduit and damaging the wires it contains:
    - a. Axial expansion or contraction up to 3/4-inch.
    - b. Angular misalignment of the axes of the conduits up to 30 degrees in all directions.
    - c. Parallel misalignment of the axes of the conduits up to 3/4-inch in all directions.
  - 2. Expansion/Deflection fitting shall be OZ/Gedney Type DX or approved equal by Crouse Hinds (Type XD).
- N. Bushings:
  - 1. Bushings for 1-inch conduit and smaller shall be self-extinguishing thermoplastic type 150 deg C temperature rating.
  - 2. Bushings for 1-1/4-inch conduit and larger shall be malleable iron body with 150 deg C insulating ring. Insulating material shall be locked in place and non-removable. Provide O-Z/Gedney Type B.

- O. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - 1. Use LFMC in damp or wet locations subject to severe physical damage.
  - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- Q. Set metal floor boxes level and flush with finished floor surface.

### 3.3 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

# 3.4 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

### END OF SECTION 260533

# **SECTION 260543**

# UNDERGROUND DUCTBANKS

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
  - 2. Handholes and boxes.
  - 3. Manholes.

#### 1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

#### 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Duct-bank materials, including separators and miscellaneous components.
  - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
  - 3. Accessories for manholes, handholes, boxes, and other utility structures.
  - 4. Warning tape.
  - 5. Warning planks.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
  - 1. Duct entry provisions, including locations and duct sizes.
  - 2. Reinforcement details.
  - 3. Frame and cover design and manhole frame support rings.
  - 4. Ladder details.
  - 5. Grounding details.
  - 6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
  - 7. Joint details.

- C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
  - 1. Duct entry provisions, including locations and duct sizes.
  - 2. Cover design.
  - 3. Grounding details.
  - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
  - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
  - 2. Drawings shall be signed and sealed by a qualified professional engineer.
- E. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- F. Qualification Data: For professional engineer and testing agency.
- G. Source quality-control test reports.
- H. Field quality-control test reports.

### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

# 1.7 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Owner's written permission.

### 1.8 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

### 1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

# PART 2 - PRODUCTS

### 2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

### 2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. ARNCO Corp.
  - 2. Beck Manufacturing.
  - 3. Cantex, Inc.
  - 4. CertainTeed Corp.; Pipe & Plastics Group.
  - 5. Condux International, Inc.
  - 6. ElecSys, Inc.
  - 7. Electri-Flex Company.
  - 8. IPEX Inc.
  - 9. Lamson & Sessions; Carlon Electrical Products.
  - 10. Manhattan/CDT; a division of Cable Design Technologies.
  - 11. Spiraduct/AFC Cable Systems, Inc.
- B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

# C. Duct Accessories:

- 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
- 2. Warning Tape: Underground-line warning tape specified in Division 26 Section.
- 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
  - a. Color.
  - b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

### 2.3 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
  - 1. Color: Gray.
  - 2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
  - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
  - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 5. Cover Legend: Molded lettering, "ELECTRIC," "TELEPHONE," or as indicated for each service.
  - 6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
  - 7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  - 8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. CDR Systems Corporation.
    - d. NewBasis.
- C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. Christy Concrete Products.

d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

# 2.4 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Tests of materials shall be performed by a independent testing agency.
  - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

### PART 3 - EXECUTION

### 3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concreteencased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- C. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- D. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- E. Underground Ducts Crossing Paved Paths, walks, driveways and roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.
- F. Ducts for electrical feeders over 600V: RNC, NEMA Type EPC-80-PVC, direct-buried, unless otherwise noted.

### 3.2 EARTHWORK

- A. Excavation and Backfill: Comply with Division Section "Earthwork" but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division Sections "Lawns and Grasses" and "Exterior Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

# 3.3 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 25 feet (7.5 m), both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
  - 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
  - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
  - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Basic Electrical Materials and Methods."
- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.
- H. Concrete-Encased Ducts: Support ducts on duct separators.
  - Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.

- b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
- 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
- 4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
- 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
- 6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
- 7. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
- 8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
  - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
- 9. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concreteencased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.
- I. Direct-Buried Duct Banks:
  - 1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
  - 2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
  - 3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division Section "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
  - 4. Install backfill as specified in Division Section "Earth Moving."
  - 5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division Section "Earth Moving."

- 6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
- 7. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.
- 8. Set elevation of bottom of duct bank below the frost line.
- 9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
- 10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
  - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
- 11. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above directburied ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

# 3.4 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below the frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavyvehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
  - 1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Section "Castin-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

### 3.5 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding."

### 3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
  - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for outof-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
  - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

### 3.7 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

# END OF SECTION 260543

# **SECTION 260548**

### VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Restraint channel bracings.
  - 2. Restraint cables.
  - 3. Seismic-restraint accessories.
  - 4. Mechanical anchor bolts.
  - 5. Adhesive anchor bolts.
- B. Related Requirements:
  - 1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
    - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
    - b. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Delegated-Design Submittal: For each seismic-restraint device.
  - 1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic forces required to select seismic restraints and for designing vibration isolation bases.
    - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

- 3. Seismic Restraint Details:
  - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
  - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
  - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
  - d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.
- 1.5 QUALITY ASSURANCE
  - A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
  - B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
  - C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
  - D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
  - E. Comply with NFPA 70.

# PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
  - 1. Basic Wind Speed: 120mph.
  - 2. Building Classification Category: III.
  - 3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction and 45 degrees either side of normal.
- B. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: D.
  - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
    - a. Component Importance Factor: 1.25.
    - b. Component Response Modification Factor: 2.0.
  - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 17%.
  - 4. Design Spectral Response Acceleration at 1.0-Second Period: 8%.
- C. Coordinate with Structural Drawing S-5.1 for additional information.

### 2.2 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Cooper B-Line, Inc.; a Division of Cooper Industries.
  - 2. Hilti, Inc.
  - 3. Mason Industries, Inc.
  - 4. Unistrut; Atkore International.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

### 2.3 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Kinetics Noise Control, Inc.
  - 2. Loos & Co., Inc.
  - 3. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

### 2.4 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Cooper B-Line, Inc.; a Division of Cooper Industries.
  - 2. Kinetics Noise Control, Inc.
  - 3. Mason Industries, Inc.
  - 4. TOLCO; a brand of NIBCO INC.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

#### 2.5 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Cooper B-Line, Inc.; a Division of Cooper Industries.
  - 2. Hilti, Inc.
  - 3. Kinetics Noise Control, Inc.
  - 4. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## 2.6 ADHESIVE ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Hilti, Inc.
  - 2. Kinetics Noise Control, Inc.
  - 3. Mason Industries, Inc.
- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless

steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

### 3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Equipment and Hanger Restraints:
  - 1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
  - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

- F. Drilled-in Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
  - 5. Set anchors to manufacturer's recommended torque using a torque wrench.
  - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

#### 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  - 5. Test to 90 percent of rated proof load of device.
- C. Seismic controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

## 3.6 ADJUSTING

A. Adjust restraints to permit free movement of equipment within normal mode of operation.

# END OF SECTION 260548

# **SECTION 260553**

## IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Identification for raceways.
  - 2. Identification of power and control cables.
  - 3. Identification for conductors.
  - 4. Underground-line warning tape.
  - 5. Warning labels and signs.
  - 6. Instruction signs.
  - 7. Equipment identification labels.
  - 8. Miscellaneous identification products.

#### 1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- 1.4 QUALITY ASSURANCE
  - A. Comply with ANSI A13.1 and IEEE C2.
  - B. Comply with NFPA 70.
  - C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
  - D. Comply with ANSI Z535.4 for safety signs and labels.

### 1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

### PART 2 - PRODUCTS

### 2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field for normal feeders, black letters on a yellow field for emergency feeders.
  - 2. Legend: Indicate voltage and system or service type.
- C. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

## 2.2 METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
  - 1. Black letters on an orange field for normal circuits, black letters on a yellow field for emergency circuits.
  - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

#### 2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

#### 2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape: Permanent, bright-colored, continuous-printed polyethylene tape.
  - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
  - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
  - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
  - 4. Embedded continuous metallic strip or core.

- B. Color and Printing:
  - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
  - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
  - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

## 2.5 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Baked-Enamel Warning Signs:
  - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
  - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
  - 3. Nominal size, 7 by 10 inches (180 by 250 mm).
- C. Metal-Backed, Butyrate Warning Signs:
  - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
  - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
  - 3. Nominal size, 10 by 14 inches (250 by 360 mm).
- D. Warning label and sign shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER ELECTRICAL SHOCK HAZARD EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING OSHA REGULATION AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

### 2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background for equipment connected to normal power source, white letters on a red background for equipment connected to an emergency power source. Minimum letter height shall be 3/8 inch (10 mm).
- B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

# 2.7 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch (5 mm).
  - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
  - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

- 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch (5 mm).
  - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
  - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
  - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
  - 1. Minimum Width: 3/16 inch (5 mm).
  - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
  - 3. UL 94 Flame Rating: 94V-0.
  - 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
  - 5. Color: Black.

### 2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

#### PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. In finished spaces, nameplates for panelboards shall be secured to the interior behind the door.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Attach signs and plastic labels with stainless screws.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
  - 1. Outdoors: UV-stabilized nylon.

- 2. In Spaces Handling Environmental Air: Plenum rated.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 8 inches (200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
- H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

### 3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 20 A: Identify with snap-around label applied in bands. Install labels at 10-foot (3-m) maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. Emergency Power Yellow.
  - 2. Power Orange.
  - 3. Fire Alarm System Red.
  - 4. Security System Blue and Yellow.
  - 5. Mechanical and Electrical Supervisory System Green and Blue.
  - 6. Telecommunication Systems Green and Yellow.
  - 7. Control Wiring Green and Red.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
  - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
    - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    - b. Colors for 208/120-V Circuits:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
      - 4) Neutral: White.
      - 5) Ground: Green.
    - c. Colors for 480/277-V Circuits:
      - 1) Phase A: Brown.
      - 2) Phase B: Orange.
      - 3) Phase C: Yellow.
      - 4) Neutral: Gray.
      - 5) Ground: Green.
    - d. All control wiring shall be color-coded when using wires of different color from the type used to designate phase wires.

- e. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- f. All emergency wiring shall have the same color-coding, but shall be clearly identified as emergency in all outlets, fixtures, etc.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
  - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Bakedenamel warning signs and metal-backed, butyrate warning signs.
  - 1. Comply with 29 CFR 1910.145.
  - 2. Identify system voltage with black letters on an orange background.
  - 3. Apply to exterior of door, cover, or other access.
  - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    - a. Power transfer switches.
    - b. Controls with external control power connections.
- J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. For electrical equipment

such as disconnect switches, motor starters, contactors, relays, pushbutton stations, etc., the label shall have the same designation as the equipment it serves. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

- 1. Labeling Instructions:
  - a. Indoor Equipment: Engraved, laminated phenolic nameplates. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
  - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
  - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
  - d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
- 2. Equipment to Be Labeled:
  - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated phenolic nameplate, "Panel (designation)", "Served from <u>"(designation)</u>".
  - b. Enclosures and electrical cabinets.
  - c. Access doors and panels for concealed electrical items.
  - d. Switchboards.
  - e. Transformers.
  - f. Electrical rooms/closets.
  - g. Emergency system boxes and enclosures.
  - h. Motor-control centers.
  - i. Enclosed switches.
  - j. Enclosed circuit breakers.
  - k. Enclosed controllers.
  - I. Variable-speed controllers.
  - m. Push-button stations.
  - n. Power transfer equipment.
  - o. Contactors.
  - p. Remote-controlled switches, dimmer modules, and control devices.
  - q. Power-generating units.
  - r. Monitoring and control equipment.
  - s. UPS equipment.

# END OF SECTION 260553

## **SECTION 260573**

#### OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

#### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study. Provide Arc-Flash Hazard Labels on all electrical distribution equipment with level as determined by Study. Electrical equipment shop drawings will not be reviewed/approved until the overcurrent protective device coordination study has been submitted.

#### 1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form.
  - 1. Coordination-study input data, including completed computer program input data sheets.
  - 2. Study and Equipment Evaluation Reports.
  - 3. Coordination-Study Report.
  - 4. Arc Fault Hazards Evaluation.

#### 1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

- 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

## PART 2 - PRODUCTS

#### 2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Engineering Analysis and Coordination Study performed by Coordinated Power Engineering, Inc., or a comparable product by one of the following:
  - 1. CGI CYME.
  - 2. EDSA Micro Corporation.
  - 3. ESA Inc.
  - 4. Operation Technology, Inc.
  - 5. SKM Systems Analysis, Inc.

#### 2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-currentcharacteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
  - 1. Optional Features:
    - a. Arcing faults.
    - b. Simultaneous faults.

#### 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. Devices to be coordinated are indicated on Drawings.

#### 3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

- 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
- 2. Impedance of utility service entrance.
- 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
  - a. Circuit-breaker and fuse-current ratings and types.
  - b. Relays and associated power and current transformer ratings and ratios.
  - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
  - d. Generator kilovolt amperes, size, voltage, and source impedance.
  - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
  - f. Busway ampacity and impedance.
  - g. Motor horsepower and code letter designation according to NEMA MG 1.
- 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
  - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
  - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
  - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
  - d. Generator thermal-damage curve.
  - e. Ratings, types, and settings of utility company's overcurrent protective devices.
  - f. Special overcurrent protective device settings or types stipulated by utility company.
  - g. Time-current-characteristic curves of devices indicated to be coordinated.
  - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
  - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
  - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

#### 3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuitbreaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
  - 1. Switchboard bus.
  - 2. Motor-control center.
  - 3. Distribution panelboard.
  - 4. Branch circuit panelboard.
  - 5. Automatic Transfer Switch.
  - 6. Manual Transfer Switch.

- B. Study electrical distribution system from normal power sources throughout electrical distribution system for Project.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, and IEEE 242.
  - 1. Transformers:
    - a. IEEE C57.12.00.
    - b. IEEE C57.96.
  - 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
  - 3. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
  - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- F. Equipment Evaluation Report:
  - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
  - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
  - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

### 3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
  - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
  - 2. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141 and IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
  - 1. Device shall not operate in response to the following:
    - a. Inrush current when first energized.
    - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
  - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that

equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
  - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
    - a. Device tag.
    - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
    - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
    - d. Fuse-current rating and type.
    - e. Ground-fault relay-pickup and time-delay settings.
  - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
    - a. Device tag.
    - b. Voltage and current ratio for curves.
    - c. Three-phase and single-phase damage points for each transformer.
    - d. No damage, melting, and clearing curves for fuses.
    - e. Cable damage curves.
    - f. Transformer inrush points.
    - g. Maximum fault-current cutoff point.
- F. Completed data sheets for setting of overcurrent protective devices.

### 3.5 ARC-FLASH HAZARD

A. Perform Arc-Flash Hazard Analysis for each piece of distribution equipment and provide results indicating personnel protective equipment required for the potential hazard. Provide arc flash hazard labels as required by the NEC on each piece of equipment indicating the calculated arc-flash hazard.

# END OF SECTION 260573

# SECTION 26 08 00 – ELECTRICAL SYSTEM COMMISSIONING

## PART 1 GENERAL

## 1.01 WORK INCLUDED

- A. Systems and equipment testing and start-up.
- B. Validation of proper and thorough installation of Division 26 systems and equipment.
- C. Functional performance testing of electrical systems.
- D. Documentation of tests, procedures, and installations.
- E. Coordination of Training Events.
- F. Generic Start-Up Procedures for electrical systems and equipment.

# 1.02 RELATED

- A. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.
- B. Commissioning Authority (CA) shall work with the Contractor and the Design Engineer to direct and oversee the Cx process and perform functional performance testing.
- C. This Section outlines the Cx procedures specific to the Division 26 Contractors. Requirements common to all Sections are specified in Sections 01 91 13 and 01 91 15 and the Commissioning Plan.

# 1.03 SCOPE

- A. The following are included in the Scope of Commissioning on this project:
  - 1. Automatic Transfer Switches
  - 2. Emergency Power Engine Generators and Distribution Systems
  - 3. Lighting and Lighting Controls
  - 4. Integrated Lighting Control Systems
  - 5. Electric Distribution Power Monitoring System

# 1.04 RELATED WORK AND DOCUMENTS

- A. Commissioning Plan: The Commissioning Plan shall be considered a part of the Contract Documents and outlines many of responsibilities, procedures and tasks throughout the Cx process. It encompasses the entire Cx process including design phase tasks prior to construction. It also describes the Functional Performance Tests that will be performed during the Acceptance Phase.
- B. Section 01 33 00 Submittals: Stipulates additional copies of submittals to be submitted and refers to other sections for additional submittal requirements related to Cx.
- C. Section 01 77 00 Project Close Out: Defines the milestones in completion incorporating the Cx process
- D. Section 01 91 13 General Commissioning Requirements: details the Cx requirements common across all divisions

- E. Section 01 91 15 Functional Testing Procedures: Outlines the generic functional testing procedures required.
- F. Individual Specification Sections: Individual sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.
- G. Section 23 08 00 HVAC Systems Commissioning: Details the commissioning procedures specific to HVAC (Division 23) work.
- O. Section 23 08 59 Building Automation Systems Commissioning: Details the commissioning procedures specific to the Building Automation System.

# 1.05 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 01 91 13 and the Commissioning Plan.

# 1.06 REFERENCE STANDARDS

- A. National Electric Code (NEC)
- B. American Society for Testing and Materials (ASTM)
- C. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)
- D. Illuminating Engineering Society (IES)
- E. Institute of Electrical and Electronics Engineers (IEEE)
- F. International Electrical Testing Association (NETA)
- G. National Electrical Manufacturers Associates (NEMA)
- H. National Fire Protection Association (NFPA)
- I. Underwriters Laboratory, Inc. (UL)
- J. LEED v4 for Building Design and Construction released in 2013.

# 1.07 DOCUMENTATION

- A. In addition to the documentation required in Section 01 91 13, Contractor shall provide to the CA the following per the procedures specified herein, in the Commissioning Plan, and in other Sections of the specification:
  - 1. Short Circuit and Coordination Study: CA shall review and recommend approval.
  - 2. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports should be provided in pdf electronic format. These include but are not limited to:
  - 3. Field Testing Agency Reports: Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in pdf electronic format. These include but are not limited to:
    - a) Electrical Testing Agency Reports per specifications
    - b) Thermographic Survey Report
    - c) Generator Load Testing
  - 4. Sample of distribution panel and receptacle labeling for approval.
  - 5. Fire Alarm System Approvals and Certifications.

# 1.08 SEQUENCING AND SCHEDULING

A. Refer Section 01 91 13 and the Commissioning Plan.

# 1.09 COORDINATION MANAGEMENT PROTOCOLS

A. Coordination responsibilities and management protocols relative to Cx are initially defined in Section 01 91 13 and the Commissioning Plan but shall be refined and documented in the Construction Phase Cx Kick-Off meeting. Contractor shall have input in the protocols and all Parties will commit to scheduling obligations. The CA will record and distribute.

# 1.10 CONTRACTOR RESPONSIBILITIES

- A. Refer to Section 01 91 13: Detailed Contractor responsibilities common to all Divisions are specified in Section 01 91 13. The following are additional responsibilities or notable responsibilities specific to Division 26.
- B. Construction Phase
  - 1. Coordinate the work of the Electrical Testing Agency and the Cx requirements.
  - 2. Coordinate the checkout of the Fire Alarm System and the approval of the regulatory authorities with the Cx process.
  - 3. Provide skilled technicians qualified to perform the work required.
  - 4. Provide factory-trained and authorized technicians where required by the Contract Documents.
  - 5. Prepare and submit required draft Start-Up Procedures and submit along with the manufacturer's application, installation and start-up information.
  - 6. Provide assistance to the CA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
  - 7. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
  - 8. Record Start-up Procedures on start-up procedure forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the Party actually performing the task or procedure.
- C. Acceptance Phase
  - 1. Assist CA in functional performance testing. Assistance will generally include the following:
    - a) Manipulate systems and equipment to facilitate testing (as dictated in Section 01 91 15 and the Commissioning Plan; in some cases, this will entail only an initial sample);
    - b) Provide any specialized instrumentation necessary for functional performance testing;

# 1.11 EQUIPMENT SUPPLIER RESPONSIBILITIES

A. Refer to Section 01 91 13.

# 1.12 CONTRACTOR NOTIFICATION AND SCHEDULING

- A. Refer to Section 01 91 13.
- 1.13 START-UP PROCEDURES AND DOCUMENTATION
  - A. Refer to Section 01 91 13.

# 1.14 EQUIPMENT NAMEPLATE DATA

A. Refer to Section 01 91 13.

# 1.15 INDEPENDENT ELECTRICAL TESTING AGENCY

A. The Independent Electrical Testing Agency shall be provided under the construction specifications and therefore included with the bid. Many of the aspects of the start-up and functional performance testing indicated herein will be accomplished under the respective section and witnessed by the CA at the indicated sample rate. CA will include applicable test results in the functional performance testing record.

# 1.16 FUNCTIONAL PERFORMANCE TESTING

A. For applicable systems and equipment, Contractor shall participate in the initial samples of Functional Performance Testing as stipulated in Section 01 91 13 and Section 01 91 15.

### 1.17 FPT ACCEPTANCE CRITERIA

A. Acceptance criteria for tests are indicated in Section 01 91 15 and in the specification Sections applicable to the systems being tested. Generally, unless indicated otherwise, the criteria for acceptance will be that specified with the individual system, equipment, component, or device, which in general conform to NFPA 70B and International Electrical Testing Association (NETA) testing specifications NETA ATS-1991.

# 1.18 TRAINING

A. Contractors, subcontractor, vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 01 91 13 and the individual Specifications.

# 1.19 SYSTEMS MANUAL CONTENT

A. Refer to Section 01 91 13 the individual Specifications.

# PART 2 PRODUCTS

#### 2.01 INSTRUMENTATION

- A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply: All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.
- B. Testing Instrumentation: Contractor shall provide all instrumentation necessary for tests for which they are responsible. CA will provide standard instrumentation for measuring medium and low voltage electrical voltage, current, power factor, power, and THD. CA will provide receptacle testers for normal and GFI receptacle tests. Contractor shall provide all other instrumentation required to accomplish the specified testing.

# PART 3 EXECUTION

# 3.01 START-UP PROCEDURES – GENERAL

A. Part 3 of this Section outlines 'generic' or minimally acceptable Start-Up Procedures (delineated as Start-Up Checks and Start-Up Tests) and individual systems Training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimum or guideline for required Contractor development of Start-Up Procedures. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized Start-Up Procedures specific to the equipment and systems installed on this project.

# 3.02 TESTING PROCEDURES

# A. Thermographic Scanning

- 1. The infrared scan shall be made when the equipment is energized and is operating at its normal capacity, unless otherwise noted. It is intended that the scan be made after the equipment has been in full operation; however, the exact time of conducting the scan will be determined by the CA near the completion of the project.
- 2. Test equipment, miscellaneous tools, and materials shall be transported properly, moved, and set up by trained personnel. Equipment used in testing shall be capable to perform all recommended procedures required by the apparatus and related equipment. All test equipment shall have certification of calibration and be in working order.
- 3. All hot spots shall be marked, identified and an infrared thermographic scanning report prepared and furnished to the Owner.
- 4. The report shall contain infrared photos of trouble spots with temperature readings.
- 5. All sources of heating problems shall be promptly reported to the Owner for corrective action by the Division 26 contractor.
- B. Grounding Systems
  - 1. Perform three-point fall-of-potential test per IEEE Standard 81 on the main grounding electrode or system. Resistance shall be no greater than 5 ohms.
  - 2. Perform the two-point method test per IEEE Standard 81 to determine the ground resistance between the main ground system and all major electrical equipment frames, system neutral, and/or derived neutral points. Resistance shall be no greater than 5 ohms.

# 3.03 PROCEDURES COMMON TO ALL SYSTEMS

- A. The following start up verifications/procedures are common to all systems
  - 1. Checkout shall proceed from devices to the components to the systems.
  - 2. Verify labeling is affixed per spec and visible
  - 3. Verify prerequisite procedures are done.
  - 4. Inspect for damage and ensure none is present.
  - 5. Verify system is applied per the manufacturer's recommendations
  - 6. Verify system has been started up per the manufacturer's recommendations
  - 7. Verify that access is provided for inspection, operation and repair
  - 8. Verify that access is provided for replacement of the equipment
  - 9. Verify the record drawings, submittal data and O&M documentation accurately reflect the installed systems
  - 10. Verify all gages and test ports are provided as required by contract documents and manufacturer's recommendations

- 11. Verify all recorded nameplate data is accurate
- 12. Installation is done to ensure safe operation and maintenance.
- 13. Verify specified replacement material/attic stock has been provided as required by the Construction Documents
- 14. Verify all rotating parts are properly lubricated
- 15. Verify all monitoring and ensure all alarms are active and set per Owner's requirements

# 3.04 AUTOMATIC TRANSFER SWITCHES (ATS)

- A. General: Provide the services of a manufacturer-certified specialist to supervise the installation, make adjustments, and perform tests on the automatic transfer switches and train Owner's maintenance personnel. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checklists and Tests used for this project.
- B. Start-Up Checks: During startup, perform the following checks and any additional checks specified in manufacturer's instructions.
  - 1. Visually inspect the systems.
  - 2. Ensure the terminations are tight and all ancillary equipment completely installed.
  - 3. Ensure all overloads are in place.
- C. Start-Up Tests: During startup, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
  - 1. Electrical tests listed in NETA 7.22.3.2.
- D. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

# 3.05 EMERGENCY POWER ENGINE GENERATORS AND DISTRIBUTION SYSTEMS

- A. General: Provide the services of a manufacturer certified specialist to supervise the installation, make adjustments, and perform tests on the engine generators and emergency power switchgear and train Owner's maintenance personnel. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checklists and Tests used for this project.
- B. Start-Up Checks: During startup, perform the following checks and any additional checks specified in manufacturer's instructions.
  - 1. Visually inspect the systems.
  - 2. Ensure the terminations are tight on power and control wiring.
  - 3. Verify all ancillary equipment completely installed.
  - 4. Ensure all overloads are in place.
  - 5. Verify that generator is set in place.
  - 6. Verify fuel connections.
  - 7. Verify radiator connections.
  - 8. Verify battery connection.
  - 9. Verify exhaust connections.
  - 10. Verify block or oil heater connection.
  - 11. Check and record engine oil level, radiator water level, and battery electrolyte level.
  - 12. Piping System Tests: Complete system test in accordance with the respective section.

- 13. Inspect the installation and access/clearance for service and maintenance to ensure it meets the project and manufacturer's requirements.
- 14. Check lubricating oil for lubricated-type equipment.
- 15. Check for proper seismic restraints.
- 16. Check that safety valves have correct setting; greater than compressor discharge pressure, but not greater than pressure rating of system components.
- 17. Check that all operating controls are set for initial safe operation.
- C. Start-Up Tests: During startup, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
  - 1. Tested generator at 50, 75, 100 percent load capacity using load banks at 100 percent power factor.
  - 2. Run load test at all loads for 30 minutes recording engine and alternator readings at the start, at 15 minutes and at 30 minutes.
  - 3. Simulate operation of all generator safeties such as high oil pressure, low oil pressure, high temperature, over speed, etc. Observe function of safeties under actual malfunction situation.
  - 4. Check for excessive vibration and noise. Correct problems.
- D. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

# 3.06 LIGHTING CONTROLS

- A. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checklists and Tests used for this project.
- B. Start-Up Checks: During startup, perform the following checks and any additional checks specified in manufacturer's instructions.
  - 1. Ensure all labeling for all relays/contactors is affixed and accurate.
  - 2. Ensure all terminations are tight.
  - 3. Check sensor placement is adequate for required duty.
  - 4. Ensure adequate access is provided to all relays/contactors, timeclocks, etc.
  - 5. Ensure all circuits for the loads are energized and ready for testing.
  - 6. Obtain all time schedules and individual device time-delay settings for all spaces from the Owner.
- C. Start-Up Tests: During startup, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
  - 1. Test, calibrate, and set all sensing (photocells, motion sensors, etc.) devices.
  - 2. Verify the correct operation of all control devices (contactors, relays, timeclocks, BAS interface relays, etc.).
  - 3. Check full load current on all breakers serving controlled lighting to ensure that the breaker is properly sized.
  - 4. Check full load current on all control device contacts serving controlled lighting to ensure that the contact rating is properly sized.
  - 5. Enter all time schedules per Owner's direction. Individual device time-delay settings are handled as part of the Room/Zone Checkout described in this Section.
  - 6. Validate all interfaces with other systems on a point-by-point basis.

D. Training: Train Owner's maintenance personnel on the operation, programming and maintenance of the lighting controls.

# 3.07 INTEGRATED LIGHTING CONTROL SYSTEMS

- A. General: Provide the services of a factory-trained manufacturer's representative to assist the contractor in the installation and start-up service of the lighting control system and train Owner's maintenance personnel as specified below. Representative will confirm the proper installation and operation of all system components. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checklists and Tests used for this project.
- B. Start-Up Checks: During startup, perform the following checks and any additional checks specified in manufacturer's instructions.
  - 1. Ensure all labeling is affixed and accurate.
  - 2. Ensure all terminations are tight.
  - 3. Check sensor placement is adequate for required duty.
  - 4. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
  - 5. Ensure all circuits for the loads are energized and ready for testing.
  - 6. Obtain all time schedules, individual device time-delay settings for all spaces, and on/off fade-rate settings from the Owner.
- C. Start-Up Tests: During startup, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
  - 1. Test, calibrate, and set all digital and analog sensing, and actuating devices. Calibrate each instrumentation device by making a comparison between the graphic display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the Start-Up Report.
  - 2. Check each digital control point by making a comparison between the control command at the control panel and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the OI display. Record the results for each device in the BAS Start-Up Report.
  - 3. Check full load current on all breakers serving controlled lighting to ensure that the breaker is properly sized.
  - 4. Check full load current on all control device contacts serving controlled lighting to ensure that the contact rating is properly sized.
  - 5. Enter all time schedules, override time-delays and on/off fade rates per Owner's direction.
  - 6. For Operator Interfaces:
    - a) Verify all elements on the graphics are functional and properly bound to physical devices and/or virtual points and that hot links or page jumps are functional and logical.
    - b) Output all specified reports for review and approval.
    - c) Verify the alarm printing and logging is functional and per requirements.
  - 7. Validate all interfaces with other systems on a point-by-point basis.
- D. Training: Train Owner's maintenance personnel on the operation and programming of the lighting control system. One day of training will be provided for up to 50 users.

# 3.08 ELECTRIC DISTRIBUTION POWER MONITORING SYSTEM

- A. General: Provide the services of a manufacturer's certified specialist to supervise the installation, make adjustments, and perform tests on the Power Monitoring System and train Owner's maintenance personnel. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checklists and Tests used for this project.
- B. Start-up checklists: Perform the following final checks before startup
  - 1. Ensure all labeling is affixed and accurate
  - 2. Ensure all terminations are tight.
  - 3. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
  - 4. Review that all field input and output devices as shown on the construction drawings and shop drawings are installed.
  - 5. Check wire supervision on all devices.
- C. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:
  - 1. Check location of all sensors and switches to ensure conformance with requirements.
  - 2. Cause activation of all devices and confirm that associated alarms and/or control sequences are initiated and verify that resulting information displayed on the Power Monitoring System is per the requirements.
  - 3. Verify interfaces with all other inter-related systems.
  - 4. For annunciator panels, validate correct graphic and correct identification of all zones. Test the action and interlocks of all override switches as appropriate
  - 5. For Operator Interfaces:
    - a) Verify all elements on the graphics are functional and properly bound to physical devices and/or virtual points and that hot links or page jumps are functional and logical.
    - b) Output all specified reports for review and approval.
  - 6. Verify the alarm printing and logging is functional and per requirements
  - 7. Validate all interfaces with other systems on a point by point basis
- D. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.
- E. Review data in Operating and Maintenance Manuals.

# END OF SECTION

# **SECTION 260923**

# LIGHTING CONTROL DEVICES

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Time switches.
  - 2. Photoelectric switches.
  - 3. Daylight-harvesting controls.
  - 4. Indoor occupancy/vacancy sensors.
  - 5. Low voltage switches.
  - 6. Lighting contactors.
  - 7. Emergency shunt relays.
- B. Related Requirements:
  - 1. Section 262726 "Wiring Devices" for snap switches.
  - 2. Section 260943 "Network Lighting Controls".

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Coverage Plans: Provide full scale plans showing locations and coverage patterns for all occupancy/vacancy sensors.
- C. Location Plans: Provide full scale plans showing locations and coverage patterns for all devices.
- D. Shop Drawings: Show installation details for occupancy and light-level sensors.
  - 1. Interconnection diagrams showing field-installed wiring.
  - 2. Include diagrams for power, signal, and control wiring.
  - 3. Include riser diagrams showing all devices and wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

### 1.6 SUBSTITUTIONS

- A. The lighting control specification and lighting control details represent the basis of design. Acceptable manufacturers must meet the criteria listed in the system requirements as well as intent demonstrated through control details. Compliant systems are required to achieve the design intent and are not required to have all the parts and pieces listed.
- B. Manufacturers not listed in the list of Acceptable Manufacturers must submit for approval within 10 days prior to bid.
- C. Acceptable Manufacturers
  - 1. Basis of Design
    - a. Acuity Brand Controls; nLight.
  - 2. Alternative Manufacturers
    - a. Wattstopper; Digital Lighting Management.
    - b. Eaton; Room Controller System.

## PART 2 - PRODUCTS

#### 2.1 GENERAL

A. Provide a wired digital networked lighting control system as indicated on the drawings. The system shall include, but not be limited to, occupancy/vacancy sensor(s), photo sensor(s), digital room controller(s), digital switches, and all interconnecting wiring required for a complete operational system. The Basis-of-Design System is the Acuity Brand Controls; nLight.

### 2.2 TIME SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide available manufacturers offering products that may be incorporated into the work include the following:
  - 1. Acuity.
  - 2. Wattstoppper.
  - 3. Eaton.
- B. Digital Time Switches: Wall switch style, electroluminescent back-lit LCD display shows timer countdown, time-out and adjustments.

#### 2.3 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
- 1. Acuity.
- 2. Wattstopper.
- 3. Eaton.
- B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turnon and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
  - 3. Time Delay: Fifteen second minimum, to prevent false operation.
  - 4. Surge Protection: Metal-oxide varistor.
  - 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
- C. Description: Solid state, with SPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turnon and turn-off levels within that range.
  - 3. Time Delay: Thirty-second minimum, to prevent false operation.
  - 4. Lightning Arrester: Air-gap type.
  - 5. Mounting: Twist lock complying with NEMA C136.10, with base.

# 2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nCm ADCX RJB or comparable product by one of the following:
  - 1. Wattstopper DLM.
  - 2. Eaton.
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
  - 1. Lighting control set point is based on two lighting conditions:
    - a. When no daylight is present (target level).
    - b. When significant daylight is present.
  - 2. System programming is done with a hand held digital configuration tool or a PC with appropriate software.
    - a. Initial setup tool: a hand held digital configuration tool. Sensor adjustments may also be made using configuration pushbuttons on the sensors.
    - b. USB interface and PC software: capability to program, read, store, modify and document device and system configuration.

- C. Ceiling-Mounted Dimming Controls: Solid-state, digital light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye in order to automatically dim a lighting zone.
- D. Electrical Components, Devices, and Accessories:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Operating Ambient Conditions: Dry interior conditions, 32 to 104 deg F (0 to 40 deg C).
  - 3. Sensor Output: Digitally communicates with room controller to dim loads based on lighting conditions. Sensor is powered from the room controller.
  - 4. Light-Level Sensor Set-Point Adjustment Range: 10 to 200 fc (108 to 2152 lux).

# 2.5 INDOOR OCCUPANCY/VACANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nCM PDT RJB, nWV PDT, or comparable product by one of the following:
  - 1. Wattstopper DLM.
  - 2. Eaton.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state digital indoor occupancy/vacancy sensors with a separate controller unit.
  - 1. Systems programming is done with a hand held digital configuration tool or a PC with appropriate software.
    - a. Initial setup tool: a hand held digital configuration tool. Sensor adjustments may also be made using configuration pushbuttons on the sensors.
    - b. USB interface and PC software: capability to program, read, store, modify and document device and system configuration.
  - 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 3. Operation:
    - a. Occupancy Sensor: Automatic-on when coverage area is occupied, and automatic-off when unoccupied.
    - b. Vacancy Sensor: Manual-on when coverage area is occupied, and automatic-off when unoccupied.
    - c. Time Delay for turning lights off adjustable over a minimum range of 1 to 30 minutes in 1-minute increments. Default setting: 20 minutes.
  - 4. Sensor Output: Digitally communicates with room controller to turn loads on and off based on occupancy. Sensor is powered from the room controller.
  - 5. Mounting:
    - a. Sensor: Suitable for mounting, ceiling mounting and corner mounting.
    - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind removable cover.
  - 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
- C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.

- 1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
- 2. Detection Coverage (Standard Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
- 3. Detection Coverage Large Room): Detect occupancy anywhere in a circular area of 2000 sq.ft. (186 sq.m) when mounted on a 96-inch-(2440-mm) high ceiling.
- D. Ultrasonic/Microphonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
  - 1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
  - 2. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  - 3. Detection Coverage (Corridor): Detect occupancy anywhere within 59 feet (18.0 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 12 feet (3.7 m).
- E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
  - 1. Sensitivity Adjustment: Separate for each sensing technology.
  - Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
  - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  - 4. Detection Coverage (corner mount): Detect occupancy anywhere within a 30 foot (9145 mm) radius when corner mounted at ceiling or on wall at 120-inches (3058 mm) above the finished floor. Provide stem mount as required to maintain manufacturer's recommended mounting height.

# 2.6 SWITCHBOX-MOUNTED OCCUPANCY/VACANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nWSX PDT LV (to match function indicated on the drawings) or comparable product by one of the following:
  - 1. Wattstopper DLM.
  - 2. Eaton.
- B. General Description: Wall-mounting, solid-state units suitable for mounting in a single-gang switchbox.
  - 1. Operation:
    - a. Occupancy Sensor: Automatic-on when coverage area is occupied, and automatic-off when unoccupied.
    - b. Vacancy Sensor: Manual-on when coverage area is occupied, and automatic-off when unoccupied.

- c. Time Delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes in 1-minute increments. Default setting: 15 minutes.
- 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
- 3. Mounting:
  - a. Sensor: Suitable for mounting in a standard outlet box.
  - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed.
- 4. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
- 5. Bypass Switch: Override the on function in case of sensor failure.
- 6. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.
- C. Dual-Technology Type: Wall mounting; detect occupancy by using a combination of PIR and ultrasonic or microphonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
  - 1. Sensitivity Adjustment: separate for each sensing technology.
  - 2. Detector Sensitivity: Detect occurrences of 6-inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
  - 3. Detection Coverage: (Standard Room): Detect occupancy anywhere within a 15 foot (4572) radius when wall mounted at 48 inches (1220 mm) above the finished floor.

## 2.7 HIGH-BAY OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nCM6 RJB with extended height lens suitable for the application or comparable product by one of the following:
  - 1. Wattstopper DLM.
  - 2. Eaton.
- B. General Requirements for Sensors: Solid-state, digital indoor occupancy/vacancy sensors with a separate controller unit.
  - 1. System programming is done with a hand held digital configuration tool or a PC with appropriate software.
    - a. Initial setup tool: a hand held digital configuration tool. Sensor adjustments may also be made using configuration pushbuttons on the sensors.
    - b. USB interface and PC software: capability to program, read, store, modify and document device and system configuration.
  - 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 3. Operation: Unless otherwise indicated, automatic-on when coverage area is occupied, and automatic-off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes in 1-minute increments. Default setting: 20 minutes.
  - 4. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).

- 5. Sensor Output: Digitally communicates with room controller to turn loads on and off based on occupancy. Sensor is powered from the room controller.
- 6. Mounting: Suitable for mounting in any position.
- 7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind removable cover.
- 8. Detector Technology: PIR.
- C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet (3.7 to 15.2 m). Detect occupancy within a circular area of 35 feet (9m) radius when mounted on a 40-foot (12-m) high ceiling.
- D. Accessories: Obtain manufacturer's handheld wireless configuration tool.

# 2.8 LOW VOLTAGE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight PODM, or comparable product by one of the following:
  - 1. Wattstopper DLM.
  - 2. Eaton.
- B. General Description: Low-voltage, momentary pushbutton switches in 1, 2, 3, 4, 5, and 8 button configuration with the following features.
  - 1. Two-way infrared (IR) transceiver for use with personal, and configuration remote controls.
  - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
  - 3. Configuration LED on each switch that blinks to indicate data transmission.
  - 4. Load/Scene Status LED on each switch button with the following characteristics:
    - a. Bi-level LED
    - b. Dim locator level indicates power to switch
    - c. Bright status level indicates that load or scene is active
  - 5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
- C. Two RJ-45 ports for connection to local network.
- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required to achieve multi-way switching.
- E. The following switch attributes may be changed or selected using a wireless configuration tool:
  - 1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
  - 2. Individual button function may be configured to Toggle, On only, or Off only.
  - 3. Individual scenes may be locked to prevent unauthorized change.
  - 4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
  - 5. Ramp rate may be adjusted for each dimmer switch.

6. Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.

# 2.9 DIGITAL ROOM CONTROLLERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nPP16 or comparable product by one of the following:
  - 1. Wattstopper DLM.
  - 2. Eaton.
- B. Description: Self configuring, digitally addressable one, two or three relay controllers with 0-10 volt control for drivers and single relay application-specific plug load controllers (if applicable) Room controllers shall be provided to match room lighting load and control requirements and have the following features:
  - 1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
  - Simple replacement Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
  - 3. Device Status LEDs to indicate:
    - a. Data transmission.
    - b. Device has power.
    - c. Status for each load.
    - d. Configuration status.
  - 4. Quick installation features including:
    - a. Standard junction box mounting.
    - b. Quick low voltage connections using standard RJ-45 patch
  - 5. Plenum rated.
  - 6. Manual override and LED indication for each load.
  - 7. Dual voltage (120/277 VAC, 60 Hz)
  - 8. Zero cross circuitry for each load.
  - 9. Controllers shall be equipped for fail-safe operation and shall be evaluated for this purpose.
  - 10. Controllers shall be activated by activation of the building fire alarm system.
  - 11. Controllers shall be equipped for activation by the building security system.
- C. On/Off/Dimming enhanced room controllers shall include:
  - 1. Real time current monitoring.
  - 2. One, two or three relay configuration.
  - 3. Efficient 250 mA switching power supply.
  - 4. Four RJ-45 local network ports.
  - 5. One 0-10 volt analog output per relay for control of compatible LED drivers.
  - 6. Optional Network Bridge for BACnet MS/TP communications (LMRC-3xx).
  - 7. The following dimming attributes may be changed or selected using a wireless configuration tool:
    - a. Establish preset level for each load from 0-100%.
    - b. Set high and low trim for each load.
    - c. Set lamp burn in time for each load up to 100 hours.

- 8. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
  - a. One relay configuration only.
  - b. Automatic-ON/OFF configuration.

# 2.10 CONFIGURATION TOOL

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight, or comparable products by one of the following:
  - 1. Wattstopper DLM.
  - 2. Eaton.
- B. A configuration tool facilitates customization of local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface. Features and functionality of the wireless configuration tool shall include:
  - 1. Two-way infrared (IR) communication with 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. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
  - 4. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
  - 5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting.
  - 6. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.

## 2.11 OUTDOOR MOTION SENSORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Bryant Electric.
  - 2. Cooper Industries, Inc.
  - 3. Hubbell Building Automation, Inc.
  - 4. Leviton Manufacturing Co., Inc.
  - 5. Lithonia Lighting; Acuity Brands Lighting, Inc.
  - 6. NSi Industries LLC; TORK Products.
  - 7. RAB Lighting.
  - 8. Sensor Switch, Inc.
  - 9. Watt Stopper.
- B. General Requirements for Sensors: Solid-state outdoor motion sensors.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. PIR Dual-technology (PIR and infrared) type, weatherproof. Detect occurrences of 6inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm). Comply with UL 773A.

- 3. Switch Rating:
  - a. Lighting-Fixture-Mounted Sensor: 1000-W incandescent, 500-VA fluorescent.
  - Separately Mounted Sensor: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
- 4. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off." With bypass switch to override the "on" function in case of sensor failure.
- 5. Voltage: Match the circuit voltage type.
- 6. Detector Coverage:
  - a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
  - b. Long Range: 180-degree field of view and 110-foot (34-m) detection range.
- 7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
- 8. Concealed, field-adjustable, "off" time-delay selector from 30 seconds up to 30 minutes. Default setting: 15 minutes.
- 9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
- 10. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as "raintight" according to UL 773A.

# 2.12 LIGHTING CONTACTORS

- A. Basis of Design Product: Subject to compliance with requirements, provide ASCO: 917-6-20-7-47M or a comparable product by one of the following:
  - 1. Allen-Bradley/Rockwell Automation.
  - 2. Square D; Schneider Electric.
  - 3. Eaton.
- B. Description: Electrically operated and mechanically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
  - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush drivers (driver with 20 percent or less total harmonic distortion of normal load current).
  - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  - 3. Enclosure: Comply with NEMA 250.
  - 4. Provide with control and pilot devices as indicated on Drawings scheduled, matching the NEMA type specified for the enclosure.
- C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
  - 1. Monitoring: On-off status.
  - 2. Control: On-off operation.

# 2.13 EMERGENCY SHUNT RELAY

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Nine 24.
  - 2. Acuity.
  - 3. Watt Stopper.
  - 4. Bodine.
  - 5. Eaton.
- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
  - 1. Coil Rating: 120/277 V.

# 2.14 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 24 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

## 3.1 PRE-INSTALLATION MEETING

- A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, Owner's representative, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.
- B. Review installation procedures and coordination required with related Work and the following:
  - 1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
  - 2. Review the specifications for low voltage control wiring and termination.
  - 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
  - 4. Discuss requirements for integration with other trades.
- C. Inspect and make notes to 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 Owner's representative.

# 3.2 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

# 3.3 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structureborne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

# 3.4 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

# 3.5 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

## 3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

- 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
- 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

## 3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
  - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
  - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
  - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

## 3.8 DEMONSTRATION

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

# END OF SECTION 260923

# **SECTION 260943**

# NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

#### 1.1 SUMMARY

A. The work covered in this section is subject to all of the requirements in the General Conditions of the Specifications. Contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system. Provide all Labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Furnish and install a complete system for the control of lighting and other equipment as indicated on the plans, detailed in the manufacturer submittal, and as further defined herein. Contractor is solely responsible to verify quantity, installation locations and wiring requirements for this project. Specific manufacturer's catalog numbers, when listed in this section are for reference only. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product availability.
- B. The system shall include but not be limited to the following list: Pre-wired, microprocessor controlled relay or dimming panels with latching relays controlled via switches, photocells, occupancy sensors, time based control, building automation systems, thermostats, and other control devices.

## 1.3 SUBMITTALS

- A. Shop Drawings: Submit drawings of lighting control system and accessories including, but not necessarily limited to, relay panels, switches, occupancy sensors, photocells and other interfaces. Shop drawings shall indicate location of each device. Plans are diagrammatical. Electrical Contractor shall verify all lighting control material requirements from approved shop drawings. "Cut Sheet" submittal not acceptable.
- B. Product Data: Submit for approval manufacturer's data for each type of product. Include construction details, descriptions, dimensions, and conductors and cables. Submit a complete bill of materials with part numbers, description and voltage specifications.
- C. One Line Diagram: Submit a one-line diagram of the system configuration indicating the type, size and number of conductors between each component. Submittals that show typical riser diagrams are not acceptable.
  - 1. Show installation details for all devices including interconnection diagrams showing all field installed wiring.
  - 2. Include diagrams for power, signal and control wiring.
- D. Coverage Plans: Show locations and coverage patterns for all occupancy sensors.

- E. Programming Forms: Submit programming forms with complete information describing the operation of the network lighting control system and all other information necessary to show proper operation of the system.
- 1.4 INFORMATIONAL SUBMITTALS
  - A. Field quality-control reports.
- 1.5 CLOSEOUT SUBMITTALS
  - A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation and maintenance manuals.
- 1.6 SUBSTITUTIONS
  - A. The lighting control specification and lighting control details represent the basis of design. Acceptable manufacturers must meet the criteria listed in the system requirements as well as intent demonstrated through control details. Compliant systems are required to achieve the design intent.
  - B. Manufacturers not listed in the list of Acceptable Manufacturers must submit for approval within ten (10) days prior to bid.
  - C. Acceptable Manufacturers
    - 1. Basis of Design
      - a. Acuity Brand Controls; nLight.
    - 2. Alternative Manufacturers
      - a. Wattstopper; Digital Lighting Management.
      - b. Eaton; Room Controller System.

## PART 2 - PRODUCTS

# 2.1 GENERAL SYSTEM REQUIREMENTS

- A. System Architecture
  - 1. System shall have an architecture that is based upon wired networkable intelligent lighting control devices, standalone lighting control zones using distributed intelligence, and system backbone for remote, time based and global operation between control zones.
  - 2. The system shall be capable of providing individually addressable switching and dimming control of the following: control zones to include multiple switch legs or circuits, relays and dimming outputs from centralized panels and networked luminaires. System shall be capable of integrating indoor and outdoor lighting controls.

- 3. Lighting control zones shall be capable of being networked with a higher level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through software.
- 4. System shall be capable of 'out of box' sequence of operation for each control zone. Standard Sequence is:
  - a. All switches control all power packs in a zone.
  - b. All occupancy sensors automatically control all power packs in the control zone with a default time out.
- B. Wired Network Control Zone Characteristics
  - 1. Following proper installation and provisions of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming. The 'out of box' default sequence of operation is intended to provide typical sequence of operation so as to minimize the system start up and programming requirements and to also have functional lighting control operation prior to system startup and programming.
  - 2. System shall be able to automatically discover all connected devices without requiring any provisioning of system or zone address.
- C. System Integration Capabilities
  - 1. The system shall be capable of interface with third party building management systems to support two-way communication using the industry standard BACnet/IP or BACnet/MSTP protocols.

## 2.2 DISTRIBUTED SYSTEM POWER, SWITCHING AND DIMMING CONTROLS

- A. Devices shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage class 2 power to the rest of the system.
- B. Device programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
- C. Power packs shall accept 120 or 277 volt VAC and shall be plenum rated.
- D. Devices shall be UL listed for load and load types as specified on the plans.

## 2.3 WIRED NETWORK RELAY AND DIMMING PANEL

- A. Relays and dimming panels shall be capable of providing the required amount of relay capacity indicated as 4-relay, 8-relay, or 16-relay, as required per panel schedules shown on drawings, with an equal number of individually 0-10v dimming outputs.
- B. Standard relays used shall have the following required properties:
  - 1. Configurable in the field to operate with normally closed or normally open behavior.
  - 2. Provide visual status of current state and manual override control of each relay.
  - 3. Be individually programmable.
- C. 0-10 VDC dimming outputs shall support a minimum of 100 mA sink current per output.

- D. Panel shall be UL924 listed for control of emergency lighting circuits.
- E. Panel shall provide a contact closure input that acts as a panel override to activate the normally configured state of all relays in the panels.
- 2.4 WIRED NETWORKED WALL SWITCHES, DIMMERS, SCENE CONTROLLERS
  - A. Wall switches & dimmers shall support the following device options:
    - 1. Number of control zones: 1, 2 or 4
    - 2. Control Types Supported: On / Off or On / Off / Dimming.
  - B. Scene controllers shall support the following device options:
    - 1. Number of Scenes: 1, 2 or 4.
    - 2. Control Types Supported:
      - a. On / Off or On / Off / Dimming
      - b. Preset Level Scene Type
      - c. Reprogrammed or other devices within daisy-chained zone so as to implement user selected lighting scene.
      - d. Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones.

## 2.5 WIRED NETWORKED OCCUPANCY AND PHOTOSENSORS

- A. Sensors shall utilize passive infrared (PIR) or dual technology (microphonic/ultrasonic plus passive infrared) to detect both the major (walking) and minor (hand) motion as defined by NEMA WD-7 standards.
- B. Sensing technologies that are acoustically passive, meaning they do not transmit sound waves to any frequency, do not require commissioning. Ultrasonic based sensing technologies may require commissioning or sensitivity adjustment due to the active nature of their technology, if factory required.
- C. Sensor coverage shall be coordinated with the floor plans. Sensors shall be available in standard and extended range, as well as being available with option for High Bay mounting.
- D. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device.
- E. Sensor mounting type shall match project design requirements as shown on the plans.
  - 1. Sensors shall have optional features for photosensor/daylight override, dimming control and low temperature/high humidity operations.
- F. The system shall support the following types of photocell-based control:
  - 1. On / Off: The control zone is automatically turned off if the photocell reading exceeds the defined setpoint and automatically turned on if the photocell reading is below the defined setpoint. A time delay or adaptive setpoint adjustable behavior may be used to prevent the system from exhibiting nuisance on/off switching.
  - 2. Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric

light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.

# 2.6 WIRED NETWORKED AUXILIARY INPUT / OUTPUT (I/O) DEVICES

- A. Auxiliary Input / Output Devices shall be specified as an input or output device with the following options:
  - 1. Contact closure input
    - a. Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, ramp light level up or down, or toggle lights on/off.
  - 2. 0-10v analog input
    - a. Input shall be programmable to function as a daylight sensor.
  - 3. RS-232/RS-485 digital input
    - a. Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
  - 4. 0-10v dimming control output, capable of sinking a minimum of 20 mA of current
    - a. Output shall be programmable to support all standard sequence of operations supported by system.

## 2.7 WIRED NETWORKED WALL SWITCH SENSORS

- A. Wall switches sensors shall support the following device options:
  - 1. User input control types supported: On / Off or On / Off / Dimming.
  - 2. Occupancy Sensing Technology: PIR or Dual Technology.
  - 3. Daylight Sensing Option: Inhibit Photosensor.

## 2.8 SYSTEM CONTROLLER

- A. System Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
- B. System Controller shall perform the following functions:
  - 1. Facilitation of global network communication between different areas and control zones.
  - 2. Time-Based control of downstream wired and wireless network device.
  - 3. Linking to an Ethernet network.
  - 4. Integration with Building Management System (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
  - 5. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
- C. System Controller shall not require a dedicated PC or a dedicated cloud connection.

- D. Device shall automatically detect all networked devices connected to it, including those connected to wired and wireless communication bridges.
- E. Devices shall have a standard and astronomical internal time clock.
- F. Shall be capable of connecting to the customers Local Area Network (LAN) via IEEE 802.11.x Wireless and IEEE 802.3 wired connection.
- G. System Controllers shall support BACnet/IP and BACnet/MSTP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.
  - 1. BACnet/MSTP shall support a minimum of 50 additional BACnet MS/TP controllers in addition to the expansion I/O modules.
  - 2. BACnet/MSTOP shall support 9600 to 115200 baud.
  - 3. System Controllers shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building (B-BC) with outlined enhanced features.
  - 4. System controllers must support BACnet/IP Broadcast Management Device (BBMS) and Foreign Device Registration (FDR).
- H. Controllers shall be equipped for fail safe operation and shall be evaluated for this purpose.
- I. Controllers shall be activated by activation of the building fire alarm system.
- J. Controllers shall be equipped for activation by the building security system.

## 2.9 SYSTEM SOFTWARE INTERFACES

- A. Management Interface
  - 1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
  - 2. Management interface must be compatible with industry-standard web browser clients.
  - 3. All system software updates must be available for automatic download and installation via the internet.
- B. Historical Database and Analytics Interface
  - 1. System shall be capable of providing a browser-based trending and monitoring interface that stores historical data for all occupancy/daylight sensors and lighting loads. Additionally, the system shall optionally upload that data to a cloud based server.
- C. Visualization Interfaces
  - 1. System shall be capable of providing an optional web-based visualization interface that displays a graphical floorplan. System data, to include status of occupancy sensors, daylight sensors and light output shall be overlaid to the floorplan to provide a graphical status page.
- D. Portable Programming Interface for Standalone Control Zones
  - 1. System shall have option for a portable handheld application interface for standalone control zones.

- 2. Programming capabilities through the application shall include, but not be limited to, the following:
  - a. Switch/occupancy/photosensor group configuration.
  - b. Manual/automatic on modes.
  - c. Turn-on dim level.
  - d. Occupancy sensor time delays.
  - e. Dual technology occupancy sensors sensitivity.
  - f. Photosensor calibration adjustment and auto-setpoint.
  - g. Trim level settings.
- E. Demand Response Client Interface
  - 1. System shall be capable of receiving a signal from the Utility or through a BAS control sequence and initiating load shed in response.
    - a. One full test of the Demand Response plan shall be performed and reports shall be included in the operations and maintenance manual.

# PART 3 - EXECUTION

## 3.1 CONTRACTOR RESPONSIBILITY

- A. Contractor shall provide the proper quantities and types of sensors for complete coverage of the areas to be controlled.
- B. Contractor shall properly install, wire, test and adjust sensors according to manufacturer instructions.
- C. Contractor shall be responsible for a complete operational system as specified.
- D. Contractor shall warrant all equipment and installation for a period of two (2) years from date of substantial completion. Contractor shall make any necessary adjustments to the system at no charge to the Owner during the warranty period.
- E. Contractor/Regional Sales Manager shall provide training to the Owner's representative in the use, operation, adjustment and maintenance of the equipment.
- F. Contractor shall set the sensors time delays per owner's instruction.

## 3.2 SYSTEM START UP AND COMMISSIONING

- A. To facilitate start-up, all devices daisy-chained together shall automatically be grouped together into a functional lighting control zone.
- B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
- C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.
- D. All system devices shall be capable of being given user defined names.

- E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.
- F. All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

# END OF SECTION 260943

# **SECTION 262200**

## LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
  - 1. Distribution transformers.

#### 1.3 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Qualification Data: For Testing Agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

#### 1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing

Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

- 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

# 1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

# 1.6 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchorbolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. Basis of Design Manufacturers: Square D Co./Group Schneider NA; Schneider Electric. Subject to compliance with requirements, provide products by one of the following:
  - 1. Powersmiths.
  - 2. Siemens Energy & Automation, Inc.
  - 3. General Electric.

# 2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.

- C. Coils: Continuous windings without splices except for taps.
  - 1. Internal Coil Connections: Brazed or pressure type.
  - 2. Coil Material: Aluminum or Copper.

# 2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 26 "Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated, NEMA 250, Type 2.
  - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Transformer Enclosure Finish: Comply with NEMA 250.
  - 1. Finish Color: Gray.
- F. Taps for Transformers Smaller Than 3 kVA: None.
- G. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- J. Energy Efficiency: All transformers shall meet or exceed Department of Energy (DOE)) 2016 efficiency requirements per 110 C.F.R. &421/196 (2015).
- K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
  - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to K-factor of 13.
  - 2. Indicate value of K-factor on transformer nameplate
- L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
  - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
  - 2. Include special terminal for grounding the shield.
  - 3. Shield Effectiveness:
    - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.

- b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
- c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- M. Wall Brackets: Manufacturer's standard brackets.
- N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

#### 2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."
- 2.5 SOURCE QUALITY CONTROL
  - A. Test and inspect transformers according to IEEE C57.12.91.

#### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 10 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, and requirements.

# 3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections: Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

# 3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

# 3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

# END OF SECTION 262200

# **SECTION 262413**

# SWITCHBOARDS

PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Service and distribution switchboards rated 600 V and less.
  - 2. Surge suppression devices.
  - 3. Disconnecting and overcurrent protective devices.
  - 4. Instrumentation.
  - 5. Control power.
  - 6. Accessory components and features.
  - 7. Identification.

## 1.3 SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
  - 5. Detail utility company's metering provisions with indication of approval by utility company.
  - 6. Include evidence of NRTL listing for series rating of installed devices.
  - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
  - 9. Include schematic and wiring diagrams for power, signal, and control wiring.
- C. Qualification Data: For qualified Installer and testing agency.
- D. Field Quality-Control Reports:

- 1. Test procedures used.
- 2. Test results that comply with requirements.
- 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Routine maintenance requirements for switchboards and all installed components.
  - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

# 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Comply with NEMA PB 2.
- G. Comply with NFPA 70.
- H. Comply with UL 891.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
- C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

## 1.6 PROJECT CONDITIONS

- A. Environmental Limitations:
  - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
    - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 2, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 6600 feet (2000 m).

## 1.7 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchorbolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

# 1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  - 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  - 3. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; a brand of Schneider Electric.
  - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 3. General Electric Company; GE Consumer & Industrial Electrical Distribution.
  - 4. Siemens Energy & Automation, Inc.
- B. Front-Connected, Front-Accessible Switchboards:
  - 1. Main Devices: Fixed, individually mounted.
  - 2. Branch Devices: Panel mounted.
  - 3. Sections front and rear aligned.
- C. Nominal System Voltage: As noted on the Drawings.
- D. Main-Bus Continuous: As noted on the Drawings.
- E. Indoor Enclosures: Steel, NEMA 250, Type 1.
- F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- G. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- H. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.
- I. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- J. Buses and Connections: Three phase, four wire unless otherwise indicated.
  - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silverplated, with copper feeder circuit-breaker line connections.
  - 2. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-), hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
  - 3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
  - 4. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical or compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- K. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

# 2.2 SURGE PROTECTION DEVICES

A. See Specification 264313: Surge Protection for Low Voltage Electrical Power Circuits, Section 2.2, Service Entrance.

# 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 100 A through 225A, field-adjustable, short-time and continuous current settings for circuit-breaker frame sizes 250A through 400A.
  - 2. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or fieldreplicable electronic trip; and the following field-adjustable settings for circuit breaker frame sizes 600A or larger:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time adjustments.
    - d. Ground-fault pickup level, time delay, and l<sup>2</sup>t response.
  - 3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
- B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current. Provide for main circuit breaker(s).
  - 1. Fixed circuit-breaker mounting.
  - 2. Two-step, stored-energy closing.
  - 3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time time adjustments.
    - c. Ground-fault pickup level, time delay, and I<sup>2</sup>t response.
  - 4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  - 5. Accessories:
    - a. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    - b. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

- c. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
- d. Phase loss protection. Provide Taylor Phase-Guard Model P phase failure relay with adjustable pick-up, adjustable time delay output undervoltage phase failure protection to include autopower shunt trip with self-contained battery assisted capacitor trip, for feeder breakers indicated on the drawings. The shunt trip device shall be fully operable and capable of tripping the circuit breaker off the line during electrical fault conditions, regardless of the available level of prevailing electric power system voltage. This particular voltage protective feature is not to trip on a clean 3 phase power break. The phase-guard relay shall reset automatically after a fault has occurred, immediately when normal voltage conditions are restored.
- 6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
- 7. Control Voltage: 120-V ac.
- C. Fuses are specified in Division 26 Section "Fuses."
- D. Provide an energy–reducing maintenance switch with local status indicator for all circuit breakers rated, or can be adjusted to, 1200A or higher.

## 2.4 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
  - 1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
  - 2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
  - 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or fourwire systems and with the following features:
  - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - a. Phase Currents, Each Phase: Plus or minus 1 percent.
    - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    - d. Megawatts: Plus or minus 2 percent.
    - e. Megavars: Plus or minus 2 percent.
    - f. Power Factor: Plus or minus 2 percent.
    - g. Frequency: Plus or minus 0.5 percent.
    - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
    - i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

## 2.5 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from controlpower transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## 2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

#### 2.7 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

- B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
  - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Comply with NECA 1.
- H. Install TVSS per manufacturer's recommendations, with lead lengths to circuit breaker disconnecting means less than 24" long.

## 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

# 3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- E. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Switchboard will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

# 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

# 3.6 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

# 3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

## END OF SECTION 262413
# **SECTION 262416**

## PANELBOARDS

PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.
  - 3. Fuse panelboards.
- B. Related sections include the following:
  - 1. "Surge Protection Devices" Division 26 Section 264300.

#### 1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Surge Protection Device.

## 1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 6. Include wiring diagrams for power, signal, and control wiring.
  - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

- C. Qualification Data: For qualified testing agency.
- D. Field Quality-Control Reports:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

#### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.
- 1.7 PROJECT CONDITIONS
  - A. Environmental Limitations:

- 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
  - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 6600 feet (2000 m).

# 1.8 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor bolt inserts into bases. Concrete, reinforcement, and form-work requirements are specified in Division 03.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## 1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Keys: Two spares for each type of panelboard cabinet lock.

## PART 2 - PRODUCTS

# 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush and surface-mounted cabinets.

- 1. Rated for environmental conditions at installed location.
  - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
  - b. Outdoor Locations: NEMA 250, Type 3R.
  - c. Wash-Down Areas/Kitchen: NEMA 250, Type 4X, stainless steel.
  - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 3R.
  - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
- 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- 3. Finishes:
  - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
  - b. Back Boxes: Same finish as panels and trim.
- 4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- 5. Multiple-Section Panelboards shall consist of two or more cabinets with identical interiors mounted under separate trims. Cabinets, trim, and doors shall be of the same size. Main lugs and busses of each section shall be rated as indicated on the Drawings. Where main breakers are indicated in multi-section panelboards, the main breaker shall be contained in one section with through-feed lugs and sub-feed cables installed within panel, equal to the incoming feeder size. All busses and lugs shall have ampere capacity equal to or greater than the main breaker ampere rating. Loads shall be divided as evenly as practical between the sections, in addition to being balanced over the phases.
- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  - 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
  - 4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Main and Neutral Lugs: Compression type.
  - 3. Ground Lugs and Bus-Configured Terminators: Compression type.
  - 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  - 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  - 6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  - 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extracapacity neutral bus.
- F. Service Entrance Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting of overcurrent protective devices.

- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

# 2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; a brand of Schneider Electric.
  - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 3. General Electric Company; GE Consumer & Industrial Electrical Distribution.
  - 4. Siemens Energy & Automation, Inc.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  - 1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or Lugs only, as indicated.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.
- 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
  - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1. Square D; a brand of Schneider Electric.
    - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - 3. General Electric Company; GE Consumer & Industrial Electrical Distribution.
    - 4. Siemens Energy & Automation, Inc.
  - B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
  - C. Mains: Circuit breaker or lugs only, as indicated.
  - D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
  - E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
  - F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

# 2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; a brand of Schneider Electric.
  - 2. Eaton Electrical Inc,; Cutler-Hammer Business Unit.
  - 3. General Electric Company; GE Consumer & Industrial Electrical Distribution.
  - 4. Siemens Energy & Automation, Inc.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 100A to 225A, field-adjustable short-time and continuous current settings for frame sizes 250A and larger.
  - 2. GFCI Circuit Breakers: Single-and two-pole configurations with Class A ground-fault protection (6-mA trip).
  - 3. Ground Fault Equipment Protection (GFEP) Circuit Breakers; Class B Ground Fault Protection (30-mA trip).
  - 4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    - g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
    - h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
    - i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
    - j. Handle Clamp: Loose attachment for holding circuit breaker handle in ON position for breakers serving clocks, telephone, and communications equipment, refrigerators, exit signs, fire alarm systems, controls, etc., to prevent accidental operation.

# 2.5 FUSIBLE BRANCH CIRCUIT PANELBOARDS

- A. Fusible Panelboards shall be Cooper Bussmann<sup>™</sup> Quick-Spec<sup>™</sup> Coordination Panelboards type QSCP. Substitutions will be accepted only if the below requirements are met and written approval is provided from the engineer.
  - 1. The electrical contractor supplies a written request to the engineer three weeks prior to the project bid date.

- 2. The electrical contractor provides product documentation to prove complete compliance with specification and all pertinent codes and standards requirements as specified in this section.
- B. Panelboard Ratings
  - 1. Panelboards shall be labeled with a short-circuit current rating equal to or greater than that indicated on the associated schedules or drawings.
  - 2. Non-service entrance rated panelboards shall be UL and cUL Listed. Service entrance rated panelboards shall be UL Listed.
  - 3. Panelboards shall be rated >= system voltages up to 600Vac/125Vdc and have a current rating as indicated on the associated schedules or drawings.
  - 4. Panelboard overcurrent protective device interrupting ratings shall be fully rated for the maximum available fault current and have a UL Listed interrupting rating of 300kA and CSA Certified interrupting rating of 200kA.
  - 5. Current ratings, configuration of poles and number of circuits shall be indicated on associated schedules or drawings.
- C. Construction
  - 1. Panelboard circuits 100A and less shall incorporate overcurrent protection and branchcircuit rated disconnecting means into a single integrated component.
  - 2. Interiors shall be factory assembled.
  - 3. Panelboard shall be equipped with a six-space spare fuse compartment for storing replacement branch circuit fuses. Spare fuse compartment shall be located behind locking panel door.
  - 4. Bus bars shall be tin-plated copper with sufficient cross sectional area to meet UL 67 temperature rise requirements.
  - 5. 200A/400A rated neutrals shall be standard, 400A or 800A rated neutral shall be provided where indicated in the associated schedules for drawings.
  - 6. Isolated or non-isolated equipment ground bar shall be provided as indicated in the associated schedules or drawings.
  - 7. Where a service-entrance rated panelboard is indicated in associated schedules or drawings, a bonded neutral and non-isolated equipment ground bar shall be provided by the manufacturer.
  - 8. Main lug conductor terminations:
    - a. MLO terminations shall be rated for 60/75°C, Cu-AI.
    - b. Main disconnect terminations shall be rated for 75°C, CU Only.
  - 9. NEMA 1 panelboards shall be field convertible for top or bottom incoming feed. NEMA 3R panelboards are bottom feed only.
- D. Main Disconnect
  - 1. Permanently installed lockout means shall be provided on the main disconnect for lockout tagout procedures.
  - 2. Main disconnect shall be quick-make, quick-break type.
- E. Branch Fused Disconnects
  - 1. Device shall have visible circuit ON/OFF indication with colored and international symbol markings.
  - 2. Device shall provide open fuse indication via permanently installed neon indicating light.
  - 3. Device shall be UL and cUL Listed 600Vac/200kA or 125Vdc/100kA voltage/short-circuit current rating, load-break disconnect with amp ratings and number of poles as indicated on the panelboard schedule.
  - 4. Fuse and disconnect assembly shall be a finger-safe component with trim installed.

- 5. Fuse and disconnect shall be mechanically interlocked so as not to allow fuse removal while fuse terminals are energized.
- 6. No special tools shall be required for fuse removal.
- 7. Devices shall have bolt-on style bus connectors.
- 8. Device housing shall be clearly marked with device amperage.
- 9. Permanently installed lockout means shall be provided on the device for lockout tagout procedures. Permanently installed means for locking device in the ON position shall also be provided.
- 10. Device shall provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 90A and 100A.
- F. Main & Branch Overcurrent Protection
  - 1. All overcurrent protective devices shall have a minimum UL Listed interrupting rating of 300kA and CSA Certified interrupting rating of 200kA.
  - Branch circuit overcurrent protection shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR finger-safe fuse with Class J\* performance characteristics.
  - 3. Main overcurrent protective devices shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR Class J time-delay fuses or Class J\* performance fuses.
  - 4. Where panelboards main fuses are installed, fuses in panelboard branch circuits shall selectively coordinate with main fuses for all overcurrents up to 200kA.
- G. 1. NEMA 1 enclosures shall be surface or flush mount as indicated in associated schedules or drawings. NEMA 3R enclosures shall be surface mount only. Door-in-door type trim shall be provided for NEMA 1 enclosures.
  - 2. Boxes shall be a nominal 20 inches wide and 5-3/4 inches deep with wire bending space per the National Electrical Code®.
  - 3. Panelboard trim shall be supplied with lockable door covering all disconnect handles.
  - 4. Panelboard trim shall be dead-front construction covering all energized parts.
  - 5. Front trim shall be lockable. All lock assemblies shall be keyed alike with like NEMA rated enclosures.
- H. Provide 20% or minimum of three fuses of each rating and type of fuse installed, in a spare fuse cabinet mounted in the same room as the fusible.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- H. Comply with NECA 1.
- I. Air distribution panels shall be installed on galvanized formed steel channels designed to distribute the weight on the supporting wall.
- J. Conduits entering the tops and bottoms of flush panels shall be located back from the front ledge of the panels to allow approximately 2-inches between the finished wall and the edge of the conduits.
- K. Where panelboard is mounted flush in a wall or partition, provide 3/4-inch empty conduit, from panelboard to ceiling space for each three or less spare single pole breakers and/or spaces in the panel unless otherwise noted on the drawings.
- L. Surge protective device units shall be installed immediately above or below panelboard enclosure, per manufacturer's recommendations, connected to circuit breaker disconnecting means with lead length of conductors less than 18 inches.

# 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

# 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- E. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- F. Panelboards will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## 3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
  - 1. Measure as directed during period of normal system loading.
  - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

# 3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

# END OF SECTION 262416

# **SECTION 262726**

## WIRING DEVICES

PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. Twist-locking receptacles.
  - 3. Snap switches.
  - 4. Pendant cord-connector devices.
  - 5. Cord and plug sets.
  - 6. Floor service outlets, poke-through assemblies, and multioutlet assemblies.
- B. Related sections include the following:
  - 1. Section 260923 Lighting Control Devices.

### 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

## 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

## 1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
  - 1. Cord and Plug Sets: Match equipment requirements.

## PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. Subject to compliance with requirements manufacturers offering products that may be incorporated into the work include, but are not limited to, the following available manufacturers' names:
  - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
  - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 3. Leviton Mfg. Company Inc. (Leviton).
  - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

# 2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, Tamper-Resistant 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Hubbell; BR20\*.
    - b. Leviton; 5362-SG\*.
    - c. Pass & Seymour; TR5262\*.

## 2.3 GFCI RECEPTACLES

- A. General Description:
  - 1. Straight blade, non-feed-through type.
  - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
  - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

- B. GFCI Convenience Receptacles, Tamper-Resistant 125 V, 20 A:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Hubbell; GFTR20.
    - b. Pass & Seymour; 2095TR.
  - 2. Receptacle(s) shall also be weather-resistant type for exterior applications.

# 2.4 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

- A. Available Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper Crouse-Hinds.
    - b. EGS/Appleton Electric.
    - c. Killark; a division of Hubbell Inc.

# 2.5 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; L520R.
    - b. Hubbell; HBL2310.
    - c. Leviton; 2310.
    - d. Pass & Seymour; L520-R.

## 2.6 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade, or as noted on the Drawings.
  - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
  - 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

# 2.7 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
  - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

# 2.8 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
    - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
    - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
    - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Pilot Light Switches, 20 A:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; 2221PL for 120 V and 277 V.
    - b. Hubbell; HPL1221PL for 120 V and 277 V.
    - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
    - d. Pass & Seymour; PS20AC1-PLR for 120 V.
  - 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
- D. Key-Operated Switches, 120/277 V, 20 A:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; 2221L.
    - b. Hubbell; HBL1221L.
    - c. Leviton; 1221-2L.
    - d. Pass & Seymour; PS20AC1-L.
  - 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Wattstopper; LVS-1.
    - b. Cooper; 1995.
    - c. Hubbell; HBL1557.
    - d. Leviton; 1257.
    - e. Pass & Seymour; 1251.

- F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Wattstopper; LVS-1K-G.
    - b. Cooper; 1995L.
    - c. Hubbell; HBL1557L.
    - d. Leviton; 1257L.
    - e. Pass & Seymour; 1251L.

# 2.9 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: 0.035-inch- (1-mm-) thick, satin-finished stainless steel or per Architect.
  - 3. Material for Unfinished Spaces: Galvanized steel.
  - 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weatherresistant, die-cast aluminum with lockable cover.

# 2.10 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, solid brass with satin finish.
- D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable.

## 2.11 MULTIOUTLET ASSEMBLIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Hubbell Incorporated; Wiring Device-Kellems.
  - 2. Wiremold Company (The).
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles. Provide in lengths indicated on the Drawings, with wiring devices in quantities and spacing indicated. Provide suitable device plates and standard receptacle plates. Provide complete with all fittings and accessories required for a complete system.

- C. Raceway material: Metal with manufacturer's standard finish. Provide power and telecommunications wiring to all devices indicated as multioutlet assemblies. Feed locations and wiring runs shall be configured such that 40 percent full capacities are not exceeded.
- D. Raceways shall be provided with full length divider for separation of power and communications devices of and wiring.
- E. Devices shall be type and color as previously specified. Label, circuit number on inside of plate of each power device.

# 2.12 FLOOR BOXES

- A. Available Products: Subject to compliance with requirements, products may be incorporated into the Work to include, but not be limited to, the following:
  - 1. Wiremold Company (The).
  - 2. Hubbell, Incorporated.
- B. Provide floor boxes as detailed on the Drawings, complete with fittings, devices, covers, etc. Floor boxes shall be cast iron for slab-on-grade applications.

## 2.13 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
  - 1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
  - 2. Wiring Devices Connected to Emergency Power System: Red.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
  - 1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
  - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:

- 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
- 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
- 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
- D. Device Installation:
  - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
  - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
  - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
  - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
  - 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
  - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
  - 8. Tighten unused terminal screws on the device.
  - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
  - 1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

# 3.2 IDENTIFICATION

- A. Comply with Division 16 Section "Identification for Electrical Systems."
  - 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

## 3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

- 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
- 2. Test Instruments: Use instruments that comply with UL 1436.
- 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
  - 1. Line Voltage: Acceptable range is 105 to 132 V.
  - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
  - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
  - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
  - 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

# END OF SECTION 262726

# **SECTION 262743**

# ELECTRIC-VEHICLE SERVICE EQUIPMENT - AC LEVEL 1 AND LEVEL 2

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

A. Section includes EVSE that provides AC Level 2 EV charging.

#### 1.3 DEFINITIONS

- A. EV: Electric vehicle.
- B. EV Cable: The off-board cable containing the conductor(s) to connect the EV power controller to the EV that provides both power and communications during energy transfer.
- C. EV Charger or EV Charging Equipment: See "EVSE."
- D. EV Connector: A conductive device that, when electrically coupled to an EV inlet, establishes an electrical connection to the EV for the purpose of power transfer and information exchange. This device is part of the EV coupler.
- E. EV Coupler: A mating EV inlet and connector set.
- F. EV Inlet: The device in the vehicle into which the EV connector is inserted, and a conductive connection is made for the transfer of power and communication. This device is part of the EV coupler.
- G. EVSE: Electric-Vehicle Supply Equipment. It includes the EV charging equipment and conductors, including the ungrounded, grounded, and equipment grounding conductors and EV cables, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for transferring energy between the premise wiring and the EV.

## 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
- 1.5 ACTION SUBMITTALS
  - A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for EV charging equipment.
- 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For EVSE.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Detail fabrication and assembly of mounting assemblies for EV charging equipment.
  - 4. Include diagrams for power, signal, and control wiring.

# 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Area plans and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Structural members to which equipment will be attached.
  - 2. Electrical service.
  - 3. Communications service, including wireless communications equipment.
- B. Qualification Data: For installer and factory-authorized service representative.
- C. Field quality-control reports.
- D. Sample Warranty: For manufacturer's warranty.

# 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For EVSE to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
  - 1. Software operating manuals.
  - 2. Program Software Backup: On USB, CD, Cloud, or approved media, complete with configuration files.
  - 3. Device address and password list.
  - 4. Printout of software application and graphic screens.

## 1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

## 1.9 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

### 1.10 FIELD CONDITIONS

- A. Wireless Survey: Complete wireless survey to determine if wireless provider signals meet or exceed manufacturer's recommended minimum values.
- B. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not exceeding minus 22 to plus 122 deg F (minus 30 to plus 50 deg C).
  - 2. Altitude: Not exceeding 6600 feet (2000 m).

## 1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of EVSE that fail(s) in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Basis of Design: Leviton evr-green 4000 Public Use Charging Station. Subject to compliance with requirements, provide products by one of the following or approved equal:
  - 1. Chargepoint CT4000.
  - 2. Bosch Power Xpress.
- B. Source Limitations: Obtain EVSE from single manufacturer.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Ambient Temperature: Minus 22 deg F to 122 deg F (Minus 30 to 50 deg C).
- B. Altitude: Sea level to 2000 feet (600 m).
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
- D. Surge Withstand: 6 kV at 3000 A.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- F. EV Charging Levels:
  - 1. Single vehicle, AC Level 2 at up to 19.2 kW per vehicle.
  - 2. Dual vehicles, AC Level 2 at up to19.2 kW per vehicle.

# 2.3 EVSE DESCRIPTION

- A. Comply with NFPA 70.
- B. Comply with:
  - 1. UL 2231-1.
  - 2. UL 2594.
  - 3. SAE J1772 for SAE combo chargers.
- C. Comply with ADA-ABA Accessibility Guidelines.
- D. Metering: Revenue grade meter.
- E. Control Power: 20 A, 110/120-V ac, 60 Hz, single phase per charger.
- F. Input Power:
  - 1. Two 40 A, 208/240-V ac, 60 Hz, single-phase services per charger.
  - 2. Dual circuits shall be interlocked.
- G. Integral GFCI.
- H. Auto-GFCI fault retry.
- I. EVSE Mounting: Bollard mount.
- J. Enclosures:
  - 1. Rated for environmental conditions at installed location.
    - a. Outdoor Locations: NEMA 250, Type 3R.
    - b. Aluminum.
    - c. Anodized.
    - d. Lockable.
    - e. Tamper resistant.
- K. EV Cable and Connectors:
  - 1. SAE J1772 connector.
  - 2. Single connectors with locking holster.
  - 3. 18-foot (6-m) cable with cable management system.
  - 4. Field-replaceable connector and cable assembly.
- L. Display Screen:
  - 1. Daylight viewable, UV-protected display with human-machine interface capability.
  - 2. Displays power, charging, charging complete, remote control, system status, faults, and service.
- M. Networking:
  - 1. WAN Communications: Cellular [**GSM/GPRS**] [**CDMA**].
  - 2. LAN Communications: [Modbus] [802.11b/g/n] [Zigbee] [10/100/1000 Base T Ethernet].
  - 3. Capable of remote configuration and reporting.

- N. Payment System:
  - 1. RFID credit card reader.
  - 2. PCI compliant.
  - 3. Capable of remote control and authorization.
- O. Charging Network: Compatible with the Chargepoint EV charging network.
  - 1. Multiple units shall have one unit designated as a master unit that is configured as a gateway unit between the EVSE and the charging network.
  - 2. Individual units shall be capable of indicating station status and availability.

## 2.4 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by utilizing cushioning materials or foam or by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for EVSE electrical conduit to verify actual locations of conduit connections before equipment installation.
- C. Examine pavement for suitable conditions where EVSE will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 413.
- B. Concrete Base Mounting:
  - 1. Install EVSE on 12-inch (300-mm) nominal-diameter and 48-inch- (1200-mm-) deep concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    - a. Install anchor bolts to elevations required for proper attachment to supported equipment.
    - b. Secure EVSE to concrete base according to manufacturer's written instructions.

- C. Wiring Method: Install cables in raceways. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- F. Disconnect: Install disconnect in a readily accessible location according to Section 262816 "Enclosed Switches and Circuit Breakers."
- G. Circuit Breakers: Comply with Section 262816 "Enclosed Switches and Circuit Breakers."
- H. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking from enclosures and components.
- I. Secure covers to enclosure.
- J. Cybersecurity:
  - 1. Software:
    - a. Coordinate security requirements with IT department.
    - b. Ensure that latest stable software release is installed and properly operating.
    - c. Disable or change default passwords to password of at least eight characters in length, using a combination of uppercase and lower letters, numbers, and symbols. Record passwords and turn over to party responsible for system operation and administration.
  - 2. Hardware:
    - a. Coordinate location and access requirements with **IT department**.
    - b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
    - c. Disable dual network connections.

## 3.3 CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Comply with grounding requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.
- D. Tighten electrical connectors and terminals according to manufacturer's published torquetightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

- E. Verify that all electrical connections have been made according to the manufacturer's instructions. Remove all burrs, shavings, and detritus from inside the enclosure.
- F. After confirming all connections, install covers and tighten fasteners to according to manufacturer's instructions.

# 3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

# 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
  - 1. For each unit of EVSE, perform the following tests and inspections:
    - a. Unit self-test.
    - b. Operation test with EV.
    - c. Network communications test.
- C. EVSE will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

## 3.6 STARTUP SERVICE

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

## 3.7 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
  - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

# 3.8 DEMONSTRATION

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

# **END OF SECTION 262743**

# **SECTION 262813**

# FUSES

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, switchboards, and enclosed controllers.
  - 2. Spare-fuse cabinets.

## 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - 3. Current-limitation curves for fuses with current-limiting characteristics.
  - 4. Coordination charts and tables and related data.
- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Ambient temperature adjustment information.
  - 2. Current-limitation curves for fuses with current-limiting characteristics.
  - 3. Coordination charts and tables and related data.

#### 1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

# 1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

# 1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

# 1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Bussmann, Inc.
  - 2. Edison Fuse, Inc.
  - 3. Ferraz Shawmut, Inc.
  - 4. Littelfuse, Inc.

## 2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

## 2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and keycoded cam lock and pull.

- 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
- 2. Finish: Gray, baked enamel.
- 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
- 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
  - 1. Feeders: Class J, time delay.
  - 2. Motor Branch Circuits: Class RK1, time delay.
  - 3. Other Branch Circuits: Class RK1, time delay, time delay.
  - 4. Control Circuits: Class CC, time delay.

# 3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s).

# 3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

## END OF SECTION 262813

# **SECTION 262816**

# ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Molded-case circuit breakers (MCCBs).
  - 4. Enclosures.

#### 1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
  - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.

- D. Field quality-control reports.
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
  - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

## 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

## 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
  - 2. Altitude: Not exceeding 6600 feet (2010 m).

# 1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

## 1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Fuse Pullers: Two for each size and type.

## PART 2 - PRODUCTS

# 2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; a brand of Schneider Electric.
  - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 3. General Electric Company; GE Consumer & Industrial Electrical Distribution.
  - 4. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, lockable in either open or closed positions, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - 4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary. Contacts would reactivate before blades open as indicated on the Drawings.
  - 5. Lugs: Compression type, suitable for number, size, and conductor material.
  - 6. Accessory Control Power Voltage: Remote-mounted and powered; 120-VAC. Provide as required with auxiliary contact kit.

## 2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; a brand of Schneider Electric.
  - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 3. General Electric Company; GE Consumer & Industrial Electrical Distribution.
  - 4. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, lockable in either open or closed position, and interlocked with cover in closed position.

# C. Accessories:

- 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
- 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
- 3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contacts, arranged to activate before switch blades open, where indicated in the Drawings.
- 4. Lugs: Compression type, suitable for number, size, and conductor material.
- 5. Accessory Control Power Voltage: Remote mounted and powered; 120 VAC. Provide as required with auxiliary contact kit.

# 2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; a brand of Schneider Electric.
  - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 3. General Electric Company; GE Consumer & Industrial Electrical Distribution.
  - 4. Siemens Energy & Automation, Inc.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
  - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
  - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact, as indicated on the drawings.
  - 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  - 6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts, where indicated on the drawings.
  - 7. Alarm Switch: One NO contact that operates only when circuit breaker has tripped, where indicated on the drawings.
  - 8. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac, as required.
  - 9. Provide with lockable handle, lockable in either open or closed position.
## 2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor Locations: NEMA 250, Type 3R.
  - 3. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
  - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
  - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

### 3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

## 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Acceptance Testing Preparation:

- 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
- 2. Test continuity of each circuit.
- D. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

## 3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

## END OF SECTION 262816

# **SECTION 262913**

## ENCLOSED CONTROLLERS

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
  - 1. Across-the-line, manual and magnetic controllers.
  - 2. Multispeed controllers.
- B. Related Sections include the following:
  - 1. Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for low-voltage power, control, and communication surge suppressors.
  - 2. Mechanical Divisions for "Variable Speed Drives" and "Power Factor Correction Capacitors".

### 1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each enclosed controller.
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Nameplate legends.
    - c. Short-circuit current rating of integrated unit.
    - d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
  - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Qualification Data: For manufacturer and testing agency.

- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Routine maintenance requirements for enclosed controllers and all installed components.
  - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

## 1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NFPA 70.
- F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

#### 1.6 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- C. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- D. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

## 1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
  - 2. Indicating Lights: Two of each type installed.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D.
  - 2. Eaton Corporation; Cutler-Hammer Products.
  - 3. General Electrical Company; GE Industrial Systems.
  - 4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
  - 5. Siemens/Furnas Controls.

### 2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
  - 1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.
- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

- 1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer source of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Control power transformers shall have primary and secondary fuse protection.
- 2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to homeplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
  - 1. Non-fusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.

## 2.3 MULTISPEED ENCLOSED CONTROLLERS

- A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
  - 1. Compelling relay to ensure that motor will start only at low speed.
  - 2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
  - 3. Decelerating relay to ensure automatically timed deceleration through each speed.

# 2.4 ENCLOSURES

- A. Description: Surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
  - 1. Outdoor Locations: NEMA 250, Type 3R.
  - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
  - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
  - 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

### 2.5 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Push-to-Test Red "Power Available" and Green "Running" nonincandescent, Pilot Lights, and Hand-Off-Automatic Selector Switches: NEMA ICS 2, heavyduty type.
- C. Control Relays: Two (2) NO/NC auxiliary contacts and adjustable time-delay relays as required by automatic control sequence.
- D. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

#### 2.6 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

# PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

## 3.3 INSTALLATION

- A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."
- C. Install Power Factor Correction Capacitors furnished under Mechanical Divisions with disconnects, overcurrent protection, wire, conduit and ground for capacitor enclosure, all in accordance with the recommendations of the capacitor manufacturer and the National Electric Code.

#### 3.4 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

# 3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
  - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
  - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.6 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

#### 3.7 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
  - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
  - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
  - 3. Report results in writing.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- D. Perform the following field tests and inspections and prepare test reports:
  - 1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control Motor Starters." Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

#### 3.8 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

### 3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01 Section "Demonstration and Training."

# END OF SECTION 262913

# **SECTION 263213**

## ENGINE GENERATORS

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes packaged engine generators for emergency use with the following features:
  - 1. Natural gas engine.
  - 2. Gaseous fuel system.
  - 3. Control and monitoring.
  - 4. Generator overcurrent and fault protection.
  - 5. Generator, exciter, and voltage regulator.
  - 6. Outdoor engine generator enclosure.
  - 7. Vibration isolation devices.
  - 8. Finishes.
- B. Related Requirements:
  - 1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

#### 1.3 DEFINITIONS

- A. EPS: Emergency power supply.
- B. EPSS: Emergency power supply system.
- C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 2. Include thermal damage curve for generator.
  - 3. Include time-current characteristic curves for generator protective device.
  - 4. Include fuel consumption in cubic feet per hour (cubic meters per hour) at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

- 5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
- 6. Include airflow requirements for cooling and combustion air in cubic feet per minute (cubic meters per minute) at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F (35, 27, 21, and 10 deg C). Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
- 7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.
- B. Shop Drawings:
  - 1. Include plans and elevations for engine generator and other components specified.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Identify fluid drain ports and clearance requirements for proper fluid drain.
  - 4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  - 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.
  - 6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer and testing agency.
- B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight, supplied enclosure, and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Source Quality-Control Reports: Including, but not limited to, the following:
  - 1. Certified summary of prototype-unit test report.
  - 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
  - 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
  - 4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
  - 5. Report of sound generation.
  - 6. Report of exhaust emissions showing compliance with applicable regulations.
  - 7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- D. Field quality-control reports.

E. Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
    - b. Operating instructions laminated and mounted adjacent to generator location.
    - c. Training plan.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

#### 1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five (5) years from date of Substantial Completion.

#### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Onan/Cummins Power Generation; Industrial Business Group.
  - 2. Kohler Co.; Generator Division.
  - 3. MTU/Spectrum Detroit Diesel.
- B. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Engine generator housing, engine generator, batteries, battery racks, silencers, sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."
  - 2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels.
  - 3. Component Importance Factor: 1.5.
- B. B11 Compliance: Comply with B11.19.
- C. NFPA Compliance:
  - 1. Comply with NFPA 37.
  - 2. Comply with NFPA 70.
  - 3. Comply with NFPA 110 requirements for Level 2 EPSS.
- D. UL Compliance: Comply with UL 2200.
- E. Engine Exhaust Emissions: Comply with EPA requirements and applicable state and local government requirements.
- F. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- G. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
  - 1. Ambient Temperature: 5 to 104 deg F (Minus 15 to plus 40 deg C).
  - 2. Altitude: Sea level to 1000 feet (300 m).

#### 2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. EPSS Class: Engine generator shall be classified as Class 48 according to NFPA 110.
- D. Service Load: As indicated on the drawings.
- E. Power Factor: 0.8, lagging.
- F. Frequency: 60 Hz.
- G. Voltage: As indicatd on the drawings.

- H. Phase: Three-phase, four-wire wye.
- I. Induction Method: Naturally aspirated or Turbocharged.
- J. Governor: Adjustable isochronous, with speed sensing.
- K. Mounting Frame: Structural-steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
- L. Capacities and Characteristics:
  - 1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
  - 2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- M. Engine Generator Performance:
  - 1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage, from no load to full load.
  - 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent stepload increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
  - 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency, from no load to full load.
  - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  - 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
  - 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
  - 7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
  - 8. Start Time: Comply with NFPA 110, Type 10, system requirements.

# 2.4 ENGINE

- A. Fuel: Natural gas.
- B. Rated Engine Speed: 1800 rpm.
- C. Lubrication System: Engine or skid mounted.
  - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  - 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

- 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499.
- E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.
  - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
  - 2. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.
  - 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant-system pressure for engine used. Equip with gage glass and petcock.
  - 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  - 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.
    - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- F. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
  - 1. Minimum sound attenuation of 25 dB at 500 Hz.
  - 2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 78 dBA or less.
- G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- H. Starting System: 24-V electric, with negative ground.
  - 1. Components: Sized so they are not damaged during a full engine-cranking cycle, with ambient temperature at maximum specified in "Performance Requirements" Article.
  - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
  - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
  - 4. Battery: Adequate capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least twice without recharging.
  - 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
  - 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F (10 deg C) regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.

- 7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
- 8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
- 9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for batteries supplied. Unit shall comply with UL 1236 and include the following features:
  - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
  - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to 140 deg F (minus 40 to plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.
  - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
  - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
  - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
  - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

## 2.5 GASEOUS FUEL SYSTEM

- A. Natural Gas Piping: Comply with requirements in Section 231123 "Facility Natural Gas Piping."
- B. Gas Train: Comply with NFPA 37.
- C. Engine Fuel System:
  - 1. Natural Gas, Vapor-Withdrawal System:
    - a. Carburetor.
    - b. Secondary Gas Regulators with atmospheric vents piped to building exterior.
    - c. Fuel-Shutoff Solenoid Valve: NRTL-listed, normally closed, safety shutoff valve. Provide 12/24VDC in addition to the engine mounted solenoid.
  - 2. Fuel Filter.
  - 3. Flexible Fuel Connector.

#### 2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

- B. Provide minimum run-time control set for 30 minutes, with override only by operation of a remote emergency-stop switch.
- C. Comply with UL 508A.
- D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.
- E. Control and Monitoring Panel:
  - 1. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
  - 2. Instruments: Located on the control and monitoring panel and viewable during operation.
    - a. Engine lubricating-oil pressure gage.
    - b. Engine-coolant temperature gage.
    - c. DC voltmeter (alternator battery charging).
    - d. Running-time meter.
    - e. AC voltmeter.
    - f. AC ammeter.
    - g. AC frequency meter.
    - h. Generator-voltage adjusting rheostat.
  - 3. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication as required by NFPA 110 for Level 2 system, and the following:
    - a. Cranking control equipment.
    - b. Run-Off-Auto switch.
    - c. Control switch not in automatic position alarm.
    - d. Overcrank alarm.
    - e. Overcrank shutdown device.
    - f. Low water temperature alarm.
    - g. High engine temperature pre-alarm.
    - h. High engine temperature.
    - i. High engine temperature shutdown device.
    - j. Overspeed shutdown device.
    - k. Coolant low-level alarm.
    - I. Coolant low-level shutdown device.
    - m. Coolant high-temperature shutdown device.
    - n. EPS load indicator.
    - o. Battery high-voltage alarm.
    - p. Low-cranking voltage alarm.
    - q. Battery-charger malfunction alarm.
    - r. Battery low-voltage alarm.
    - s. Contacts for local and remote common alarm.
    - t. Remote manual-stop shutdown device.
- F. Connection to Datalink:
  - 1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
  - 2. Provide connections for datalink transmission of indications to remote data terminals via ModBus."

- G. Remote Alarm Annunciator:. An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
  - 1. Overcrank alarm.
  - 2. Coolant low-temperature alarm.
  - 3. High engine temperature pre-alarm.
  - 4. High engine temperature alarm.
  - 5. Low lube oil pressure alarm.
  - 6. Overspeed alarm.
  - 7. Low-fuel main tank alarm.
  - 8. Low coolant level alarm.
  - 9. Low-cranking voltage alarm.
  - 10. Contacts for local and remote common alarm.
  - 11. Audible-alarm silencing switch.
  - 12. Run-Off-Auto switch.
  - 13. Control switch not in automatic position alarm.
  - 14. Lamp test.
  - 15. Low-cranking voltage alarm.
- H. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.
- I. Remote Emergency-Stop Switch: Flush; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
- J. Remote Ethernet Monitoring: Provide remote network monitoring of the emergency generator and automatic transfer switches, requiring only Microsoft Internet Explorer 6.0 or higher browser software on a PC monitoring system. The remote network monitoring shall allow simultaneous monitoring of the equipment by several authorized users, with three levels of password protection: monitor, monitor and control, and administrator. Provide Cummins PowerCommand iWatch 100 Remote Network Monitoring System or approved equal by generator manufacturer. The system shall be UL listed, CE and FCC compliant.
  - 1. Features shall include monitoring engine data, alternator data and control system status (including a full set of NFPA 110 alarms), and transfer switch status (source availability, source data and source connected.) Data shall be presented to the users in a pictorial format, with graphical user interface. The system shall be configurable for user access codes, with configurable names and passwords.
  - 2. The generator set and transfer switches shall be interconnected with a PowerCommand FT-10 LonWorks network. The network shall be connected to the PowerCommand iWatch 100 (internet server) module, which shall be connected to a TCP/IP Ethernet connection. The PowerCommand iWatch 100 shall include:
    - a. iLON100e3 software to set up the remote network interface. Add configuration plug-ins and install software upgrades for LonMaker for Windows.
    - b. PowerCommand iWatch 100 Support CD, including factory image files for LonWork's gensets, network databases, type/format files, security profiles and documentation needed for the PowerCommand iWatch 100 application.
    - c. iLON100e3 Hardware as required for network interface with transfer switches and generator set monitoring and controls
    - d. Miscellaneous accessories required for a fully functional system, including—but not limited to—Ethernet patch cable, LonWorks cabling, and power cord.

3. The iWatch 100 hardware equipment shall be DIN rail-mountable. Provide in NEMA 1 enclosure, suitable for use in ambient temperature of 0-50 deg C (32-122 deg F).

## 2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
  - 1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.
- B. Generator Disconnect Switch: Molded-case type; 100 percent rated.
  - 1. Trip Rating: Matched to generator output rating.
  - 2. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.
- C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:
  - 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
  - 2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
  - 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
  - 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- D. Ground-Fault Indication: Comply with NFPA 70 Article 700, "Emergency System" signals for ground fault.
  - 1. Indicate ground fault with other engine generator alarm indications.

## 2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

- E. Range: Provide limited range of output voltage by adjusting the excitation level.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Dripproof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
  - 1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
  - 2. Maintain voltage within 15 percent on one step, full load.
  - 3. Provide anti-hunt provision to stabilize voltage.
  - 4. Maintain frequency within 10 percent and stabilize at rated frequency within two seconds.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Subtransient Reactance: 12 percent, maximum.

## 2.9 OUTDOOR ENGINE GENERATOR ENCLOSURE

- A. Description: Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
  - 1. Sound Attenuation Level: 2 for 50dBA maximum sound level measured on all four sides of enclosure, at 23 feet (10 meters) with generator running at full load.
- B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph (160 km/h).
- C. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Hinged Doors: With padlocking provisions.
- E. Space Heater: Thermostatically controlled and sized to prevent condensation.
- F. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.
- G. Muffler Location: Within enclosure.

- H. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.
  - 1. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
  - 2. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

### 2.10 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
  - 1. Material: Standard neoprene separated by steel shims.
  - 2. Shore A Scale Durometer Rating: 45.
  - 3. Number of Layers: Three.
- B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
  - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
  - 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- C. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.
- D. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.
- E. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

### 2.11 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

# 2.12 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
  - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

- B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
  - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
  - 2. Test generator, exciter, and voltage regulator as a unit.
  - 3. Full-load run.
  - 4. Maximum power.
  - 5. Voltage regulation.
  - 6. Transient and steady-state governing.
  - 7. Single-step load pickup.
  - 8. Safety shutdown.
  - 9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
  - 10. Report factory test results within 10 days of completion of test.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
- B. Examine roughing-in for piping systems and electrical connections to verify actual locations of connections before packaged engine generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.
- C. Equipment Mounting:
  - 1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete.
  - 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
  - 3. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of [1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure enclosure to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."

- D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- E. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.
  - 1. Install flexible connectors and steel piping materials according to requirements in Section 232116 "Hydronic Piping Specialties."
  - 2. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."
- F. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.
- G. Gaseous Fuel Piping:
  - 1. Natural gas piping, valves, and specialties for gas distribution are specified in Section 231123 "Facility Natural Gas Piping."
- H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

## 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect engine exhaust pipe to engine with flexible connector.
- D. Gaseous Fuel Connections:
  - 1. Connect fuel piping to engines with a gate valve and union and flexible connector.
  - 2. Install manual shutoff valve in a remote location to isolate gaseous fuel supply to the generator.
  - 3. Vent gas pressure regulators outside building a minimum of 60 inches (1500 mm) from building openings.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.
- G. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

### 3.4 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

## 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
  - 1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.
    - a. Visual and Mechanical Inspection:
      - 1) Compare equipment nameplate data with Drawings and the Specifications.
      - 2) Inspect physical and mechanical condition.
      - 3) Inspect anchorage, alignment, and grounding.
      - 4) Verify that the unit is clean.
  - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test. Provide load bank for testing as required.
  - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
    - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    - c. Verify acceptance of charge for each element of the battery after discharge.
    - d. Verify that measurements are within manufacturer's specifications.
  - 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and floatcharging conditions.
  - 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
- D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
- F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.
- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

## 3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

## 3.7 DEMONSTRATION

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

# END OF SECTION 263213

# **SECTION 263600**

## TRANSFER SWITCHES

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
  - 1. Automatic transfer switches.
  - 2. Non-Automatic (Manual) transfer switches.
  - 3. Remote annunciation systems.
- B. Related Sections include the following:
  - 1. Division 26 Section "Engine Generator".

### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
- C. Qualification Data: For manufacturer and testing agency.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Features and operating sequences, both automatic and manual.
  - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

#### 1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than four hours from time of notification.

- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain automatic transfer switches, remote annunciators and packaged engine generator through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NEMA ICS 1.
- F. Comply with NFPA 70.
- G. Comply with NFPA 110.
- H. Comply with UL 1008 unless requirements of these Specifications are stricter.

## PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Contactor Transfer Switches:
    - a. Emerson; ASCO Power Technologies, LP.
    - b. Russell Electric.

### 2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electricmotor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
  - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
  - 2. Switch Action: Double throw; mechanically held in both directions.
  - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."
  - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
  - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
  - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- K. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

# 2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

- A. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.
- B. Automatic Transfer-Switch Features:
  - 1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
  - 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
  - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
  - 4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
  - 5. Test Switch: Simulate normal-source failure.
  - 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
  - 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
  - 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
  - 9. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
  - 10. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
  - 11. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    - b. Push-button programming control with digital display of settings.
    - c. Integral battery operation of time switch when normal control power is not available.
  - 12. Provide load shed capability for ATSs indicated on the drawings.

### 2.4 NONAUTOMATIC (MANUAL) TRANSFER SWITCHES

- A. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." Switch shall be capable of transferring load in either direction with either or both sources energized.
- B. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.
- C. Nonautomatic Transfer-Switch Accessories:
  - 1. Pilot Lights: Indicate source to which load is connected.
  - 2. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternate-source sensing circuits.
    - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - b. Emergency Power Supervision: Red light with nameplate engraved "Alternate Source Available."
- D. Unassigned Auxiliary Contacts: One set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

## 2.5 REMOTE ANNUNCIATOR SYSTEM

- A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
  - 1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
  - 2. Switch position.
  - 3. Switch in test mode.
  - 4. Failure of communication link.
- B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
  - 1. Indicating Lights: Grouped for each transfer switch monitored.
  - 2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
  - 3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
  - 4. Lamp Test: Push-to-test or lamp-test switch on front panel.

### 2.6 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

## PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
  - 1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."
- B. Annunciator and Control Panel Mounting: Flush in wall, or wall-mount, unless otherwise indicated on Drawings.
- C. Identify components according to Division 26 Section "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

#### 3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

#### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Manufacturer's Field Service Tests and Inspections:
  - 1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
  - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulationresistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    - a. Check for electrical continuity of circuits and for short circuits.
    - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    - c. Verify that manual transfer warnings are properly placed.

- d. Perform manual transfer operation.
- 4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
  - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
  - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
  - c. Verify time-delay settings.
  - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
  - e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- 5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
  - a. Verify grounding connections and locations and ratings of sensors.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Remove and replace malfunctioning units and retest as specified above.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."
- B. Coordinate this training with that for generator equipment.

# END OF SECTION 263600

# **SECTION 264113**

## LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes a UL Master Label lightning protection system for the Building and associated structures, to be provided.
- B. Lighting protection system shall be included in Base Bid.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
  - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
  - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
- C. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- D. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
- E. Field quality-control reports.
- F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
  - 1. Ground rods.
  - 2. Ground loop conductor.
  - 3. Surge Protection Devices.

### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by UL and LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- B. System Certificate:
  - 1. UL Master Label.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

#### 1.5 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

## PART 2 - PRODUCTS

- 2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS
  - A. Comply with UL 96 and NFPA 780.
  - B. Roof-Mounted Air Terminals: NFPA 780, Class II, aluminum unless otherwise indicated.
    - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - a. East Coast Lightning Equipment Inc.
      - b. ERICO International Corporation.
      - c. Harger.
      - d. Heary Bros. Lightning Protection Co. Inc.
      - e. Independent Protection Co.
      - f. Preferred Lightning Protection.
      - g. Robbins Lightning, Inc.
      - h. Thompson Lightning Protection, Inc.
    - 2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
    - 3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for singlemembrane roof system materials. Comply with requirements in Division 07 roofing Sections.
    - 4. Provide protection caps on air terminal located at high traffic roof areas, walkways and service areas.
  - C. Main and Bonding Conductors: Aluminum, except down conductors will be Copper.
  - D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad steel; 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:
  - 1. Down conductors.
  - 2. Interior conductors.
  - 3. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.
- D. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
  - 1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
- E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

### 3.2 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

#### 3.3 FIELD QUALITY CONTROL

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

# END OF SECTION 264113
## **SECTION 264300**

## SURGE PROTECTION DEVICES (SPD)

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes Surge Protection Devices for low-voltage power, control, and communication equipment.
- B. Related Sections include the following:
  - 1. Division 26 Section "Panelboards" Surge Protection Devices.
  - 2. Division 26 Section "Switchboards" factory-installed Surge Protection Devices.

#### 1.3 LISTING REQUIREMENTS

A. UL 1449 Third Edition listed.

### 1.4 SUBMITTALS

- A. Drawings: Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, mounting provisions, connection notes, wire size and wiring diagram.
- B. Equipment Manual: The manufacturer shall furnish an installation manual with installation notes, start-up and operating instructions for the specified SPD. Installation instructions shall clearly state whether the system requires an external overcurrent device to maintain the system's UL 1449 listing.
- C. Verification that all SPD are UL tested and labeled with 20kA (In) nominal discharge rating for compliance to UL96A Lightning Protection Master Label and NFPA 780.
- D. UL 1449 stipulation for fused SPD The manufacturer's authorized representative is required to submit the following:
  - 1. Certify that the SPD is UL 1449 listed (UL Card) with UL Card.
  - 2. Indicate the type of internal or external fusing that is incorporated in the SPD and what impact the fusing has on the performance of the device with respect to surge capacity and clamping levels.
- E. Manufacturer must provide independent testing on repetitive capability and maximum surge current rating of service entrance suppressor units. This shall be performed at a nationally recognized lab not affiliated with the manufacturer.

- 1. Single pulse surge current capacity: single pulse surge current tested in a mode at rated surge currents. Single pulse surge current capacities of 200,000 A or less per mode are established by single pulse testing in a mode.
- 2. Single pulse surge current capacity test: an initial UL 1449 defined as 1.2 x 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 500A and 3kA short circuit current waveform is applied to benchmark the unit's suppression voltage.
- 3. A single pulse surge of maximum rated surge current (for units rated over 200,000A per mode, components or sub-assemblies are tested) magnitude with an approximated 8 x 20µs waveform is then applied. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.
- F. Minimum Repetitive Surge Current Capacity.
  - 1. Service entrance suppressor units should be tested repetitively to verify repetitive capacity.
  - 2. Minimum Repetitive Surge Current Capacity Test:
    - a. An initial UL 1449 surge defined as 1.2 x 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 500A and 3kA short circuit current waveform is applied to benchmark the unit's suppression voltage.
    - b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges defined as a 1.2 x 50µs 10kV or 20kV open circuit voltage waveform and an 8 x 20µs 10,000A short circuit current waveform are then applied at one minute intervals.
    - c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.
  - 3. Survival is achieved if the suppression voltage measured from the two UL 1449 surges does not vary by more than 10%.
  - 4. Proof of such testing shall be the test log generated by the surge generator.
- G. Short Circuit Fuse Testing.
  - 1. Each design configuration shall be short circuit tested in accordance with the type of fusing utilized in the suppression path.
  - 2. Short Circuit Fuse Test:
    - a. Testing shall include application of a sustained overvoltage that causes the unit to enter a bolted fault condition.
    - b. This bolted fault condition shall occur with the full rated AIC current of the fuse available.
  - 3. The fuse shall fail in a safe manner with no physical or structural damage to the unit and any failure shall be self-contained within the unit.
- H. Surge Current Fuse Testing.
  - 1. Each design configuration shall be surge tested with fusing in series to verify that a transient of maximum surge current capacity magnitude is fully suppressed without fuse failure, operation or degradation.
- Service Entrance SPD must be subjected to a series of waveforms as described in IEEE C62.41.2-2002. Clamping voltage measurements were taken throughout the tests to evaluate any deviations in performance as a result of the surges. Injected surges included the 1.2/50µs, 8/20µs waveforms at levels of 6kV/500A for bench marking, and high current 10/1000µs surges at 1.5, 3.1, 3.6 and 6.2 kA levels.

### 1.5 STANDARDS

- A. UL 1449 3<sup>rd</sup> Edition. Underwriters laboratories safety standard for Surge Protection Devices.
- B. NEC Article 285. National electrical code 2008 rev.
- C. NFPA 780. STANDARD FOR THE INSTALLATION OF LIGHTNING PROTECTION SYSTEMS.
- D. IEEE (Institute of Electrical and Electronic Engineering Inc.) C62.41.1 and C62.41.2 2002 rev. IEEE C62.45 – 2002 rev
  IEEE Std. 1100 "The Emerald Book" Section 8.4.2.5
- E. CBEMA (ITIC) and IEC (Computer Business Equipment Manufacturers Association or Information Technology Industry Council and International Electrotechnical Commission define clamping voltage tolerance guidelines for sensitive equipment)
- F. All manufacturers must comply with above listed standards and any additions current revisions of industry standards. All products that do not comply with current industry standards will not be accepted.

#### 1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain all suppression devices and accessories through one source from a single manufacturer.

### 1.7 PROJECT CONDITIONS

- A. Placing into Service: Do not energize or connect service entrance equipment, panelboards, control terminals, or data terminals to their sources until the surge protective devices are installed and connected.
- B. Each protection device shall have a capacitive filtering system connected in each Line to Neutral (L→N)(Wye) mode or Line to Line (L→L)(Delta) mode to provide EMI/RFI noise attenuation.
- C. Protection modes: The SPD shall provide Line to Neutral  $(L\rightarrow N)(Wye)$ , Line to Ground  $(L\rightarrow G)(Wye \text{ or Delta})$ , Line to Line  $(L\rightarrow L)(Delta)$  and Neutral to Ground  $(N\rightarrow G)(Wye)$  protection.
- D. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
  - 1. Maximum Continuous Operating Voltage (MCOV): Should be tested to 115% per UL 1449 3rd.
  - 2. Operating Temperature: 0 to 50 deg F.
  - 3. Humidity: 0 to 95 percent, noncondensing.
  - 4. Altitude: Less than 12,000 feet above sea level.

### 1.8 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

- B. All devices must be installed on the load side of the facility after the first overcurrent protection or disconnect.
- C. Products shall be installed external to service, distribution, and branch panel equipment. All SPDs must have the same or greater AIC, Interrupting, or Fault rating of the equipment the SPD is protecting.

# 1.9 WARRANTY

- A. General Warranty: Special warranties specified in this article shall not deprive owner of other rights owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by contractor under requirements of the Contract Documents.
- B. Manufacturer shall provide a product warranty for a period of not less than ten (10) years from date of installation. Warranty shall cover unlimited replacement of SPD or modules during the warranty period. Those firms responding to this specification shall provide proof that they have been regularly engaged in the design, manufacturing and testing of SPD for not less than thirty (30) years.

## PART 2 - PRODUCTS

## 2.1 SERVICE ENTRANCE SUPPRESSORS

- A. Acceptable Manufacturers and Models:
  - 1. LEA International Inc. PV400
  - 2. Current Technology SL2-200-L2
  - 3. Liebert SI-040-ANCE
  - 4. ASCO approved equal.
  - 5. Surge Suppression, Inc. approved equal.
- B. SPD shall be a multi-stage parallel protector. Please see one-line diagram and panelboard schedule to confirm voltages. SPD's minimum surge current capacity shall be **400kA** per phase (L-N plus L-G) and **200kA** per mode (L-N, L-G, L-L and N-G).
- C. SPD shall be modular design with field replaceable modules per phase. Each protection module shall have a visual indicator that signifies that the protection circuitry is powered. The unit shall not be taken off line to verify integrity of system. Redundant status indicators shall be mounted on the front of the door that monitors the system protection circuitry.
- D. SPD shall contain a technology that utilizes multiple thermally protected metal oxide varistors (MOV) per mode.
- E. SPD shall be labeled as minimum with Type 2 (verifiable at UL.com). Every component of every mode, including N-G, shall be protected by internal thermal protection. SPDs relying upon external or supplementary installed safety overcurrent protection do not meet the intent of this specification.
- F. All primary transient paths shall utilize copper wire, aluminum bus bar and lugs of equivalent capacity to provide equal impedance interconnection between phases. No plug-in module or components shall be used in surge carrying paths.

- G. SPD shall provide the following monitoring features: dry contacts, digital surge counter and audible alarm with alarm disable switch. Equipment shall utilize a NEMA 12 enclosure.
- H. If no circuit breaker is available add internal disconnect switch.

## 2.2 DISTRIBUTION PANEL SUPPRESSORS

- A. Acceptable Manufacturers and Models:
  - 1. LEA International Inc. LS 200P
  - 2. Current Technology CGP100
  - 3. Liebert LM-100-ANCE
  - 4. ASCO approved equal.
  - 5. Surge Suppression, Inc. approved equal.
- B. SPD shall be a multi-stage parallel protector. Please see one-line diagram and panelboard schedule to confirm voltages. SPD's minimum surge current capacity shall be 200kA per phase (L-N plus L-G) and 100kA per mode (L-N, L-G, L-L and N-G).
- C. SPD shall meet all specification requirements in section 2.1 (D through F) and as follows:
  - 1. SPD shall be modular design with a field replaceable module. SPD shall provide the following monitoring features: dry contacts, surge counter and audible alarm with alarm disable switch. SPD shall utilize a NEMA 12 enclosure. If no circuit breaker is available add internal disconnect switch.

#### 2.3 PANELBOARD SUPPRESSORS

- A. Acceptable Manufacturers and Models:
  - 1. LEA International Inc. SP100
  - 2. Current Technology CGP60
  - 3. Liebert ACV-III-RKE
  - 4. ASCO approved equal.
  - 5. Surge Suppression, Inc. approved equal.
- B. SPD shall be a multi-stage non-parallel protector. Please see one-line diagram and panelboard schedule to confirm voltages. SPD's minimum surge current capacity shall be **100kA** per phase (L-N plus L-G) and **50kA** per mode (L-N, L-G, L-L and N-G).
- C. SPD shall meet all specification requirements in section 2.1 (D through F) and as follows:
  - 1. SPD shall be non-modular design. SPD shall provide the following monitoring features: dry contacts and audible alarm. SPD shall utilize a NEMA 1 enclosure or better.

## PART 3 - EXECUTION

#### 3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. The specified unit shall be installed external to switchboard, distribution and panelboard as stand alone. Internal products will not be accepted.

- B. The specified service entrance/switchboard/switchgear system shall be installed with the shortest lead length possible from the power conductor(s) it is protecting, must have a grounding of 25 Ohms (NEC Article 250.56) or less and shall avoid any unnecessary or sharp bends. Utilize a 60 amp breaker for connection means. See manufacturer's installation manual. If no circuit breaker is available, see one-line diagram for connection information.
- C. The specified distribution system shall be installed with the shortest lead length possible from the power conductor(s) it is protecting, must have a grounding of 25 Ohms (NEC Article 250.56) or less and shall avoid any unnecessary or sharp bends. Utilize a 60 breaker for connection means. See manufacturer's installation manual. If no circuit breaker is available, see one-line diagram for connection information.
- D. The specified branch panelboard system shall be installed with the shortest lead length possible from the power conductor(s) it is protecting, must have a grounding of 25 Ohms (NEC Article 250.56) or less and shall avoid any unnecessary or sharp bends. Utilize a 30 amp breaker for connection means. See manufacturer's installation manual. If no circuit breaker is available, see one-line diagram for connection information.

## 3.2 CONNECTIONS

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

## 3.3 FIELD QUALITY CONTROL

- A. Testing: Contractor shall perform the following field quality-control testing:
- B. Testing: Perform the following field quality-control testing:
  - 1. After installing surge protective devices, but before electrical circuitry has been energized verify that the unit voltage and connecting equipment voltage is same.
  - 2. Verify per NEC 285.6 that the SPD AIC rating is equal or greater to connecting equipment.
  - 3. Complete startup checks according to manufacturer's written instructions.
  - 4. Perform visual and mechanical inspection of each unit to verify light functionality.

## END OF SECTION 264300

# **SECTION 265100**

## INTERIOR LIGHTING

PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Interior lighting fixtures, lamps, and drivers.
  - 2. Emergency lighting units.
  - 3. Exit signs.
  - 4. Lighting fixture supports.
- B. Related Sections:
  - 1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy and vacancy sensors, and multipole lighting relays and contactors.
  - 2. Division 26 Section "Wiring Devices" for snap switches and wall switches.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. LED: Light-emitting diode.
- D. LER: Luminaire efficacy rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting fixture, including driver if provided.
- G. THD: Total harmonic distortion.

## 1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of lighting fixture including dimensions.
  - 2. Emergency lighting units including battery and charger.
  - 3. Driver, THD, input power, input voltage, power factor, connector type, starting temperature.
  - 4. Energy-efficiency data.
  - 5. Life, output (delivered lumens) CCT, and CRI color rendition fidelity (Rf) and gamut (Rg) per IES TM-30.
  - 6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, drivers, and accessories identical to those indicated for the lighting fixture as applied in this Project.
    - a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power and control wiring.
- C. Samples: For each lighting fixture indicated in the Interior Lighting Fixture Schedule. Each Sample shall include the following:
  - 1. Lamps and drivers, installed.
  - 2. Cords and plugs.
  - 3. Pendant support system.
- D. Installation instructions.
- E. Product Certificates: For each type of driver for bi-level and dimmer-controlled fixtures, from manufacturer.
- F. Field quality-control reports.
- G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
- H. Warranty: Sample of special warranty.
- I. LEED Submittals:

### 1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

#### 1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

## 1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
  - 2. Warranty Period for Emergency and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
- B. Special Warranty for Drivers: Manufacturer's standard form in which driver manufacturer agrees to repair or replace drivers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Electronic Drivers: Ten years from date of Substantial Completion.
- C. Special Warranty for LED luminaires: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace LED modules and drivers that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
  - 1. Warranty Period: Ten years from date of Substantial Completion.

## 1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. LED replacement modules: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

- 2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
- 3. Battery and Charger Data: One for each emergency lighting unit.
- 4. Drivers: Five for every 100 of each type and rating installed. Furnish at least one of each type.
- 5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection.
  - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are limited to manufacturers specified, per Lighting Fixture Schedule.
  - 2. Basis & Design Product: The design of each item of exterior luminaire and its support is based on the first product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

#### 2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
  - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least 0.125-inch (3.175 mm) minimum unless otherwise indicated.
    - b. UV stabilized.
  - 2. Glass: Annealed crystal glass unless otherwise indicated.

- G. Factory-Applied Labels: Comply with UL 1598. Include recommended LED modules and drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  - 1. Label shall include the following lamp and driver characteristics:
    - a. "USE ONLY" and include specific LED module.
    - b. CCT and CRI for all luminaires.

### 2.3 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-metal hydride type.
    - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    - f. Integral Self-Test: Factory-installed electronic device automatically initiates coderequired test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

### 2.4 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
  - 1. Battery: Sealed, maintenance-free, nickel metal hydride type.
  - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
  - 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
  - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  - 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
  - 7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

8. Integral Self-Test: Factory-installed electronic device automatically initiates coderequired test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## 2.5 LED LUMINAIRES

- A. A LED luminaire consists of LED light engine and driver, heat-sink, fixture housing, and optic assembly where applicable.
  - 1. Temperature: Minimum starting temperature of -30 deg C (-22 deg F), minimum 40 deg C (104 deg F) ambient temperature rating.
  - 2. Life and Lumen Maintenance: Plus 50,000 hours rated life at greater than 70% lumen maintenance.
  - 3. CRI and CCT: 3500 deg K (+/- 275 K) CCT and greater than 80 CRI.
  - 4. Transient Voltage Protection: Rated to withstand 2.5 kV of transient line surge.
  - 5. Photometric Data and Test Reports: Comply with IESNA LM-79-08, IESNA LM-80-08, and ANSI C78.377-08.
  - 6. Radio Frequency Interference: Comply with CAP 106B Telecommunications (Control of Interference) Regulations.
  - 7. Luminaires and components thereof shall comply with UL 8750 Standard of Safety.
  - 8. Ten-year warranty on luminaire including LED light engine and driver.
  - 9. Power Factor: 90 percent minimum.
  - 10. Total Harmonic Distortion Rating: Less than 20 percent.
  - 11. RoHS compliant.
  - 12. Sound Rating: Class A.
  - 13. Overload, short circuit, and thermal protection.
  - 14. LED luminaires must be listed with the Design Lights Consortium or Energy Star Qualified Products list.
  - 15. Comply with UL 1598-08 NMX-J-307/1-ANCE/C22.2 NO.250.0-08, Luminaires, LEDs.

## 2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channeland angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge (2.68 mm).
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge (2.68 mm).
- F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

## PART 3 - EXECUTION

- 3.1 GENERAL:
  - A. Comply with NECA/IESNA 500-2006 "Standard for Installing Indoor Commercial Lighting systems."

## 3.2 INSTALLATION

- A. Lighting fixtures:
  - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
  - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Remote Mounting of Drivers: Distance between the driver and fixture shall not exceed that recommended by driver manufacturer. Verify, with driver manufacturers, maximum distance between driver and luminaire.
- D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
  - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
  - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
  - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
  - 4. Install at least one independent support wire from structure to a tab on lighting fixture. Wire shall have breaking strength of the weight of fixture at a safety factor of 3.
- E. Suspended Lighting Fixture Support:
  - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
  - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
  - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

## 3.4 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

### 3.5 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

#### 3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
  - 1. Adjust aimable luminaires in the presence of Architect.

# END OF SECTION 265100

# **SECTION 265600**

## EXTERIOR LIGHTING

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Exterior luminaires with lamps and drivers.
  - 2. Luminaire-mounted photoelectric relays.
  - 3. Poles and accessories.
- B. Related Sections include the following:
  - 1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. Lumen: Measured output of lamp, luminaire, or both.
- D. Luminaire: Complete lighting fixture, including ballast housing if provided.
- E. LED: Light-emitting diode.
- F. Pole: Luminaire support structure, including tower used for large area illumination.
- G. Standard: Same definition as "Pole" above.
- H. THD: Total harmonic distortion.

#### 1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
- B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4.

- C. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-4.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
  - 1. Wind speed for calculating wind load for poles 50 feet (15 m) or less in height is 80 mph (129 km/h).

### 1.5 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  - 2. Details of attaching luminaires and accessories.
  - 3. Details of installation and construction.
  - 4. Luminaire materials.
  - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, drivers, and accessories.
    - a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
    - b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  - 6. Photoelectric relays.
  - 7. Drivers, including energy-efficiency data THD, input power, input voltage, power factor, starting temperature, Backlight, Uplight and Glare (B.U.G.) rating.
  - 8. Life, output, lumens, CCT, CRI, and energy-efficiency data.
  - 9. Materials, dimensions, and finishes of poles.
  - 10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
  - 11. Anchor bolts for poles.
  - 12. Manufactured pole foundations.
- B. Shop Drawings:
  - 1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
  - 2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
  - 3. Wiring Diagrams: Power and control wiring.
  - 4. Lighting Calculations: Point-by-point calculations for fixtures shown on the Site Plan and noted on the Lighting Fixture Schedule. Calculation grid shall be 10'-0" on center, horizontal.
- C. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and ballasts.
- D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

- E. Qualification Data: For agencies providing photometric data for lighting fixtures.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

### 1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C2, "National Electrical Safety Code."
- D. Comply with NFPA 70.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

#### 1.8 COORDINATION

A. Coordinate layout and installation of lighting fixtures, poles and support components with other construction, including utilities, storm water abatement, and trees.

#### 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
  - 1. Warranty Period for Luminaires: Ten years from date of Substantial Completion.
  - 2. Warranty Period for Metal Corrosion: Ten years from date of Substantial Completion.
  - 3. Warranty Period for Color Retention: Ten years from date of Substantial Completion.

4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than five years from date of Substantial Completion.

### 1.10 EXTRA MATERIALS

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

LED replacement modules:

- 1. Lamps: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
- 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
- 3. Drivers: 5 for every 100 of each type and rating installed. Furnish at least one of each type.
- 4. Globes and Guards: 10 for every 20 of each type and rating installed. Furnish at least one of each type.

#### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified per the Lighting Fixture Schedule.
  - 2. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the first product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

### 2.2 LUMINAIRES, GENERAL REQUIREMENTS

- 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. 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:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.
- 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-SP 8, "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.
    - a. Color: As selected from manufacturer's standard catalog of colors.
- 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.
  - 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.

### 2.3 LED LUMINAIRES:

- A. A LED luminaire consists of LED light engine and drive, heat-sink, fixture housing, and optic assembly where applicable.
  - 1. Temperature: Minimum starting temperature of -30 deg C (-22 deg F), minimum 40 deg C (104 deg F) ambient temperature rating.
  - 2. Life and Lumen Maintenance: Plus 50,000 hours rated life at greater than 70% lumen maintenance.
  - 3. CRI and CCT: 4000 deg K (+/- 275 K) CCT and greater than 70 CRI.
  - 4. Transient Voltage Protection: Rated to withstand 10 kV of transient line surge for the pole mount fixtures, 6kV for wall mount.
  - 5. Photometric Data and Test Reports: Comply with IESNA LM-79-08, IESNA LM-80-08, and ANSI C78.377-08.
  - 6. Radio Frequency Interference: Comply with CAP 106B Telecommunications (Control of Interference) Regulations.
  - 7. Luminaires and components thereof shall comply with UL 8750 Standard of Safety.
  - 8. Ten-year warranty on luminaire including LED light engine and driver and integral control devices.
  - 9. Power Factor: 90 percent minimum.
  - 10. Total Harmonic Distortion Rating: Less than 20 percent.
  - 11. RoHS compliant.
  - 12. Sound Rating: Class A.
  - 13. Overload, short circuit, and thermal protection.
  - 14. LED luminaires must be listed with the Design Lights Consortium or Energy Star Qualified Products lists.
  - 15. Comply with UL 1598-08 NMX-J-307/1-ANCE/C22.2 NO.250.0-08, Luminaires, LEDs.

## 2.4 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
  - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
  - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  - 1. Materials: Shall not cause galvanic action at contact points.
  - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
  - 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

### 2.5 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
  - 1. Shape: Round, straight.
  - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
  - 1. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
  - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
  - 3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch (76-by-127-mm) handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
- F. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- G. 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.
- H. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.
- I. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- J. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.
- K. 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 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.
    - a. Color: As selected by Architect from manufacturer's full range.

### 2.6 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

## PART 3 - EXECUTION

### 3.1 GENERAL:

A. Comply with NECA/IESNA 501-2006 "Standard for Installing Exterior Lighting Systems".

## 3.2 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
  - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

### 3.3 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
  - 1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
  - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
  - 3. Trees: 15 feet (5 m).
- C. 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 03 Section "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
  - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
  - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
  - 3. Install base covers, unless otherwise indicated.
  - 4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

- E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.
- F. Raise and set poles using web fabric slings (not chain or cable).

## 3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches (100 mm) 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 03 Section "Cast-in-Place Concrete."

#### 3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### 3.6 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole, unless otherwise indicated.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole.
  - 2. Install grounding conductor and conductor protector.
  - 3. Ground metallic components of pole accessories and foundations.

#### 3.7 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
  - 1. Verify operation of photoelectric controls.
- C. Illumination Tests:

- 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
  - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
  - b. IESNA LM-64, "Photometric Measurements of Parking Areas."
  - c. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

#### 3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section that includes Demonstration and Training.

## END OF SECTION 265600

# SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Communications equipment coordination and installation.
  - 2. Sleeves for pathways and cables.
  - 3. Sleeve seals.
  - 4. Grout.
  - 5. Common communications installation requirements.
  - 6. Training Requirements

# 1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

# 1.4 SUBMITTALS

A. Product Data: For sleeve seals.

### 1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of communications equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  - 3. To allow right of way for piping and conduit installed at required slope.
  - 4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

- C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."."

# PART 2 - PRODUCTS

# 2.1 SLEEVES FOR PATHWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
    - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

## 2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, product by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.
  - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
  - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

# PART 3 - EXECUTION

## 3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

## 3.2 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 inches (50 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) 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 or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) 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-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

## 3.3 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.

#### 3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."
- B. Provide Specified Technologies, Inc (STI) EZ Path Cable Pathway sleeves at all cable penetrations through walls in the telecommunications rooms (MDF and IDF rooms). Provide multiple Series 33 and Series 44 as needed to serve cabling being installed plus 100% spare capacity.

# 3.5 TRAINING REQUIREMENTS

A. All contractor-provided training and demonstrations required in Division 27 and 28 specification sections shall be video recorded. Contractor shall provide the services of an audio-video recording specialist for the recording and making of the DVD of each training session.

# **END OF SECTION 270500**

# SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Telecommunications mounting elements.
  - 2. Backboards.
  - 3. Telecommunications equipment racks and cabinets.
  - 4. Telecommunications service entrance pathways.
  - 5. Grounding.
- B. Related Sections:
  - 1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
  - 2. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.
  - 3. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

#### 1.3 DEFINITIONS

- A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- B. BICSI: Building Industry Consulting Service International.
- C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches (152 mm) in width.
- D. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- E. LAN: Local area network.
- F. RCDD: Registered Communications Distribution Designer.
- G. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.

H. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

## 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
  - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
- C. Qualification Data: For **Installer**, qualified layout technician, installation supervisor, and field inspector.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  - 1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
  - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
  - 3. Field Inspector: Currently registered by BICSI as Commercial Installer, Level 2 to perform the on-site inspection.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- D. Grounding: Comply with ANSI-J-STD-607-A.

## 1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

## 1.7 COORDINATION

- A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
  - 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
  - 2. Record agreements reached in meetings and distribute them to other participants.
  - 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
  - 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

## PART 2 - PRODUCTS

## 2.1 PATHWAYS

- A. General Requirements: Comply with TIA/EIA-569-A.
- B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.
  - 1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
  - 2. Support brackets with cable tie slots for fastening cable ties to brackets.
  - 3. Lacing bars, spools, J-hooks, and D-rings.
  - 4. Straps and other devices.
- C. Cable Trays:
  - 1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cable Management Solutions, Inc.
    - b. Cablofil Inc.
    - c. Cooper B-Line, Inc.
    - d. Cope Tyco/Allied Tube & Conduit.
    - e. GS Metals Corp.

- 2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick.
  - a. Basket Cable Trays: 12 inches (300 mm) wide and 4 inches (100 mm) deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
  - b. Ladder Cable Trays: Nominally 18 inches (455 mm) wide, and a rung spacing of 12 inches (305 mm).
  - c. Channel Cable Trays: One-piece construction, nominally 4 inches (100 mm) wide. Slot spacing shall not exceed 4-1/2 inches (115 mm) o.c.
- D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
  - 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

# 2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."
- B. Paint all backboards "BLACK".

## 2.3 EQUIPMENT FRAMES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. AMP; a Tyco International Ltd. company.
  - 2. Cooper B-Line, Inc.
  - 3. Middle Atlantic Products, Inc.
  - 4. Ortronics, Inc.
- B. General Frame Requirements:
  - 1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
  - 2. Module Dimension: Width compatible with EIA 310 standard, 19-inch (480-mm) panel mounting.
  - 3. Finish: Manufacturer's standard, baked-polyester powder coat.
- C. Floor-Mounted Racks: Modular-type, steel or aluminum construction.

- 1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug[, and a power strip].
- 2. Baked-polyester powder coat finish.
- D. Modular Freestanding Cabinets:
  - 1. Removable and lockable side panels.
  - 2. Hinged and lockable front and rear doors.
  - 3. Adjustable feet for leveling.
  - 4. Screened ventilation openings in the roof and rear door.
  - 5. Cable access provisions in the roof and base.
  - 6. Grounding bus bar.
  - 7. Rack-mounted, 550-cfm (260-L/s) fan with filter.
  - 8. Power strip.
  - 9. Baked-polyester powder coat finish.
  - 10. All cabinets keyed alike.
- E. Cable Management for Equipment Frames:
  - 1. Metal, with integral wire retaining fingers.
  - 2. Baked-polyester powder coat finish.
  - 3. Vertical cable management panels shall have front and rear channels, with covers.
  - 4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

## 2.4 POWER DISTRIBUTION SWITCHED RACK UNIT

- A. Power Distribution Switched Rack Unit: Comply with UL 1363.
  - 1. Rack mounting.
  - 2. Twenty Four 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
  - 3. LED indicator lights for power and protection status.
  - 4. LED indicator lights for reverse polarity and open outlet ground.
  - 5. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
  - 6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
  - 7. Cord connected with 10-foot (3.05-m) line cord.
  - 8. Rocker-type on-off switch, illuminated when in on position.
  - 9. Peak Single-Impulse Surge Current Rating: 26 kA per phase.
  - 10. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.
  - 11. Power Distribution Switched Rack Unit shall be APC Switched PDU model # AP7030.
  - 12. Provide one Power Distribution Switched Rack Unit in each equipment rack and cabinet.

## 2.5 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

- B. Telecommunications Main Bus Bar:
  - 1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
  - 2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
  - 3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
- C. Comply with ANSI-J-STD-607-A.

## 2.6 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

## PART 3 - EXECUTION

## 3.1 ENTRANCE FACILITIES

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- B. Install underground pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.
- C. Comply with NECA 1.
- D. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- E. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
- F. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

### 3.2 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- B. Comply with BICSI TDMM, "Firestopping Systems" Article.
- C. Provide Specified Technologies, Inc (STI) EZ Path Cable Pathway sleeves at all cable penetrations through walls in the telecommunications rooms (MDF and IDF rooms). Provide multiple Series 33 and Series 44 as needed to serve cabling being installed plus 100% spare capacity.
## 3.3 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI-J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
  - 1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

#### 3.4 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration including optional identification requirements of this standard.
- C. Labels shall be preprinted or computer-printed type.

# END OF SECTION

## SECTION 27 13 00 - SOUND SYSTEMS

## PART 1 - GENERAL

## 1.1 GENERAL

#### A. PERFORMANCE GUARANTEE

- 1. The intent of this specification is to provide complete and satisfactory operating systems for the pickup, amplification, distribution, and reproduction of audio program material. This specification may also make certain provisions to incorporate pickup and reproduction in the future. The Contractor unconditionally guarantees that the system delineated in this specification will meet or exceed the following performance criteria:
- 2. Maximum average program level shall be no less than 75 +/- 3 dB for all multipurpose and auditorium areas. Maximum average program level shall be no less than 89 +/- 3 dB for the gymnasium sound system anywhere in the audience area.
- 3. Each room shall have a uniformity of coverage within +/- 3 dB within the overall audience area.
- 4. All system speakers shall have a dedicated processor for each speaker zone provided. Each specific processor shall enhance the specific EQ curves of the speakers, and provide a limiting feature for the specific speaker used. Systems that do not include a dedicated processor with their speakers shall be not accepted.
- 5. The Cafeteria and Gymnasium sound systems are designed to operate independently
- 6. Provide interface to fire alarm system to mute local sound system upon activation of fire alarm system.
- 7. Provide interface to Public Address / Intercom system to over-ride / mute the local sound system during an "All Call" announcement from the public address/intercom system.
- B. Scope of Work:
  - 1. The intent of this specification is to provide a complete and satisfactory operating system for the pickup, amplification, distribution, and reproduction of voice and/or audio program material. The system shall be of modular design to facilitate both expansion and service and shall be completely transistorized. All equipment and installation material required to fulfill the above shall be furnished whether or not specifically enumerated herein.

- 2. Work shall include the furnishing of all labor, material tools, and system described in these Specifications and shown in the system described in these Specifications and shown in the drawing. The work shall include, but not be limited to:
  - a) Installation of equipment rack, cabinet.
  - b) Internal wiring of rack.
  - c) Installation of speakers.
  - d) Wiring of all speakers.
  - e) Installation of microphone jacks and wire.
  - f) Making equipment function as intended.
  - g) Install priority override relays from the building intercom to seize the local speakers during an emergency all call.
  - h) Spectrum analysis and tuning of the system
  - i) Documentation of functions and wiring.
  - j) Documentation
- 3. Upon completion of the work, the contractor shall submit all as built drawings, including system single line block diagrams and wiring diagrams including all speaker line, microphone, rack interconnection, cabling, relay wiring and function and adjustment settings.
- 4. Contractor shall also provide a complete set of manufacturer's specification sheets on all major items of equipment, including operating instructions, where relevant.
- 5. Additionally, the Contractor shall provide two 1-hour training sessions of inservice training with the system. Training shall thoroughly familiarize owner's representative with all aspects of the system operation.
- 6. Carefully examine the contract documents, the blue prints, and/or the installation site for omissions, existing conditions and general hands-on knowledge. The Contractor shall provide a complete system that fully meets all conditions defined throughout this specification. The contractor shall interface with the Engineer, the Electrical Contractor, the Mechanical Contractor, the Drywall/Finishing Contractor(s), and the General Contractor to: coordinate schedules, define device locations, separate conduit groups, install equipment mounts, and generally coordinate all other aspects of the project. The contractor shall be responsible to insure that the supplied equipment and it's installation meet the requirements set forth herein.

## 1.2 SUBMITTALS

- A. Specification Sheets shall be submitted on all items including cable types.
- B. Submit outline drawing of system control cabinet showing relative position of all major components.
- C. Shop drawings, scaled, detailing sound system including, but not limited to, the following:

- 1. Speaker mounted details and wiring arrangement
- 2. Equipment cabinet detail drawing, equipment and rack elevation
- 3. Scaled floor plans and elevations
- 4. Wall Plate drawings
- D. Submit wiring diagrams & block diagrams showing typical connections for all equipment.
- E. Submit a numbered Certificate of Completion for installation, programming, and service training, which identifies the installing technician(s) as having successfully completed the technical training course(s) provided by the system manufacturer.
- F. Provide a DVD of all As-Built drawings and O&M Documentation.
- G. Provide a complete block line drawing of the sound system with submittals of all equip-ment for review.
- H. All of the above drawings must be CAD generated in a format usable by AutoCAD. All Shop Drawings must be approved by a BiCSi Registered Communications Distribution Designer whose Official Seal and Registration Number must be affixed to each drawing. At the specifying authority's request, DVD or CD disks containing the required drawings must be provided.

## 1.3 QUALITY ASSURANCE

- A. All items of equipment shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.
- B. The contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least 5 years. The contractor shall be a duly authorized distributor of the installed equipment and the other equipment supplied with full manufacturer's warranty privileges.
- C. The contractor shall show satisfactory evidence, upon request, that he or she maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The contractor shall maintain at his or her facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.
  - 1. Contractor must have an employee on staff, throughout the term of the contract, with NICETAudio Level III certification and shall be required to provide the name of that individual on the bid form.
  - 2. Contractor shall have an employee on staff, licensed for the installation of low voltage wiring, and shall be required to provide the name of that individual on

the bid form.

- 3. Contractor is shall have an employee on staff, throughout the term of the contract with a Registered Communications Distribution Designer (RCDD) professional rating as designated by the Building Industry Consulting Service International (BICSI)
- 4. The contractor shall have an ICIA Certified Technical Specialist (CTS) on staff.

D. The system shall be guaranteed for a period of one (1) year from the date of acceptance against defective materials, workmanship and improper adjustment. Any defective material shall be replaced with no charge to the owner, provided it does not show abuse.

1. Provide one year of maintenance to consist of at least two (2) semi-annual visits to the site. The maintenance shall consist of, but not be limited to:

- a. level changes to optimize system operation
- b. re-equalization if feedback problems are prevalent
- c. cleaning of all tape heads and transports
- d. routine adjustment and calibration of any equipment
- e. any malfunctions reported by the owner
- f. Notify the owner at least 48 hours prior to a maintenance visit.

E. To assure compliance with all governmental codes, regulations, and laws, the installing contractor shall have on its staff a Master Electrician licensed within the State of Maryland. Proof of such licensing shall be included with the contractor's submittal.

## PART 2 - PRODUCTS

## 2.1 GENERAL

- A. All materials specified herein shall be new and shall be the manufacturer's latest design, permanently labeled with the model number and serial number. The products specified are distributed through:
- B. Provide intelligible, permanent identification on or adjacent to all controls; fuses and/or circuit breakers, connectors, receptacles, terminal blocks; amplifiers, equalizers, mixers, etc. The identification shall clearly indicate the function of the item and be numbered or lettered to correspond with the function, circuit, and/or locations, consistent with the field and shop drawings.
- C. All devices connected to the electrical system and all auxiliary equipment necessary for the operation of the equipment associated with systems specified, herein shall be designed to operate from 105 to 130 volts, 60 hz alternating current service, with stable performance, fully in accordance with these Specifications, and shall have integral fuse or circuit breaker protection.
- D. Provide sound reinforcement of speech in the areas described. Provide reproduction of program audio in these areas. This reinforcement and reproduction shall be in the form of actual sound from loudspeakers.

- E. Provide for microphone pickup, both wired and wireless, of "live" program material from locations as shown on the drawings. Provide microphone-level input circuits to accommodate the above. Provide at least one (1) spare microphone input channels in each system.
- F. Provide for program playback, both permanent and temporary, of pre-recorded audio and/or video material from the Equipment Cabinets as shown on the drawings. Provide input circuits to accommodate the playback sources specified herein. Also provide an input, for portable sources, on the front panel of the cabinet. Each input shall have a dedicated volume control as integral features of the mixer(s).
- G. Provide even distribution of the reinforced sound throughout the listening area, typically +/-3dB front to back and side to side for the one-octave band centered at 4000 Hz. Total variation from the "worst" to the "best" seat shall not exceed +/-4dB.
- H. Provide uniform frequency response throughout the audience area. Typically, +/-3dB from 100Hz-10KHz as measured with broadband pink noise and a 1/3-octave real-time analyzer.
- I. Provide adequate dynamic range to reproduce program peaks without distortion. The sound systems shall be capable of delivering 85dBA SPL (95dB SPL for the Gymnasium) average program level with an additional 10dB peaking margin to any audience position.
- J. Gymnasium Sound Reinforcement System. The system shall consist of a mixer, power amplifier, digital signal processor, wireless microphones and microphone jacks. Wall-mounted speakers will provide for a stand alone system in the Gym. The system shall be capable of reproducing speech and music from both live and pre-recorded sources.
- K. Cafeteria Sound Reinforcement System. The system shall consist of a mixer, power amplifier, digital signal processor, wireless microphones and microphone jacks. Wall-mounted speakers will provide for a stand alone system in the Cafeteria. The system shall be capable of reproducing speech and music from both live and pre-recorded sources.
- L. Hearing Assistance System Provide a reinforcement system for the hearing impaired in both the Gymnasium and Cafeteria. The hearing assistance system shall be an **induction loop** system that shall not limit operation to certain seats or areas of the room(s). Provide approximately 20-40 milliseconds of high-quality digital signal delay to help in the localization of the sound source. Contractor is to ensure that each system will work without interference when the systems are in "separate" mode.

## 2.2 GYMNASIUM SOUND EQUIPMENT

- A. FM Wireless Microphone System:
  - 1. The Wireless Microphone shall be a miniature battery-operated FM transmitter and matching AC powered receiver incorporating compander circuitry to increase dynamic range and signal-to-noise ratio. The systemshall operate in the UHF band, utilizing dual diversity antennae for reducing multipath problems. A backlit LCD display shall show the operating frequency, antenna signal strength and transmitter battery life. An auto-detect mode shall allow the receiver to synchronize with the matng transmitter.
  - 2. Each system shall incorporate agile frequency tuning and shall be able to operate with up to 12 wireless systems simultaneously.

- 3. Minimum Overall Performance Requirements:
  - a. Frequency Response: 45-15,000 Hz,  $\pm 2$  dB (without mic).
  - b. Distortion: 0.5% THD.
  - c. Dynamic Range: >100dB, A weighted.
  - d. RF Carrier Frequency: 518-752 MHz.
  - e. Frequency Sensitivity: -105dBm for 12dB SINAD
- 4. Hand-Held Transmitter, provide two:
  - a. Hand-held microphone with built-in transmitter, batteries, and antenna.
  - b. LCD display showing frequency and battery life.
  - c. Power Output: 30mW RF using 2 AA batteries.
  - d. Acceptable Products:
    - 1) Sennheiser SKM135G2 with mating swivel stand adapter.
    - 2) Shure SLX2/SM58 with mating swivel stand adapter.
- 5. Receiver, provide two:
  - a. AC powered receiver in  $\frac{1}{2}$  rack package with dual antennas.
  - b. A backlit LCD displaying frequency, RF signal and transmitter battery life. .
  - c. Balanced microphone and line-level output on rear panel.
  - d. Provide two remote 1/4 wave antennas and mounts per receiver
  - e. Acceptable Products:
    - 1) Sennheiser EM100G2/NT with rack mount.
    - 2) Shure SLX4 with rack mount.
- B. General Purpose Microphone:
  - 1. Usable in floor or desk stand using included clip.
  - 2. Hyper-cardioid or Super-cardioid directional characteristic.
  - 3. 15 dB or greater front-to-back discrimination from 100-8000 Hz.
  - 4. Frequency response  $\pm 3 \text{ dB}$  from 120-12kHz.
  - 5. Provide with two 25' braided shield mic cable with cast zinc alloy connectors per microphone.
  - 6. Acceptable products, provide two:
    - a. Shure Beta 58M.
    - b. Sennheiser e845.
    - c. EV RE16.
- C. Microphone Stands

1. Floor stand with 10" diameter cast iron base. Two-section extendible tube of 7/8" and 5/8" seamless steel tubing. Standard 5/8"-27 thread, adjustable from 37-60 inches in height. Black tube and base. Provide two Atlas MS-12CE microphone stand.

3. Desk stand with small footprint base and short mounting tube. Tube to be 4-8" in height and finished in black. Base to be isolating type, black in color weighing at least 1.5lb. Provide two Atlas DS-2E.

#### D. Microphone Mixer:

1. The mixer shall be have eight (8) mic/line channels. Each input shall have a dedicated front panel level control.

- 2. A master level control, bass and treble tone controls shall be provided.
- 3. The output section shall deliver +22dBV at less than 0.009% THD.
- 4. Acceptable product, provide one:
  - a. Rolls RM-82.

b. Approved equal by Peavey or Rane with a minimum of the above stated features and performance.

## E. CD Player/iPod Dock

- 1. Provide a rack-mount stereo CD Player with built-in iPod dock and infrared remote control.
- 2. Integrated unbalanced analog and digital outputs.
- 3. Acceptable products, provide one:
  - a. Tascam CD200i
    - b. No other CD Players will be acceptable.
- H. Programmable Dual DSP Processor:
  - 1. Tamper-resistant unit without front panel controls, with on-board non-volatile memory for multiple presets, field programmable internally with security code lockout, or by external device.

2. Minimum requirements are: two input channels; two output channels; 1/3 octave-band analog cut/boost filters on ANSI preferred 31.5-16,000 Hz center frequencies; automatic feedback suppressor, input signal delays; output signal delays; compressor/limiters; and programmable gain settings.

- 3. Programming of settings using personal computer running Windows 98 minimum.
- 4. Dimensions: 1-3/4" high for standard 19" rack-mounting.
- 5. Minimum Performance Requirements:
  - a. Frequency Response:  $\pm 0.5$  dB, 20-20,000 Hz. with controls set for flat response.
  - b. Distortion: 0.003% THD typical at +4dBu, 1kHz, odB gain.
  - c. Dynamic Range: >107dB, unweighted.
- 6. Programmable Dual DSP Processor-Acceptable Products:
  - a) dbx Drive Rack 220i
  - b). Shure DFR22.
  - c) Biamp Nexia SP
- I. Power Amplifier:
  - 1. Solid-state, two channel amplifier. Capable of withstanding +22dBu input.
  - 2. Front panel indication of clipping.
  - 3. All inputs via barrier type terminal strips, Phoenix or XLR-type connectors. All outputs via barrier type terminal strips or 5-way binding posts.
  - 4. Minimum Performance Requirements:
    - a. Frequency Response: ± 1 dB, 20-20,000 Hz.
    - b. Distortion: 0.003W THD, 20-20.000 Hz at 10% below full rated output.
    - c. Signal to Noise Ratio: 100 dB below rated 8 ohm output 20Hz 20kHz.
    - d. Inputs: min. 20k, balancedI
    - e. Minimum Rated Load Impedance: 4 ohms, able to operate safely into any load.
  - 5. Output Power:
    - 300W per channel minimum into 8 ohms.
  - 6. Acceptable Products, provide one:
    - a. QSC CMX500V
    - b. Crown CDi1000
    - c. Approved equal by Ashly
- J. Loudspeakers

1. The loudspeakers shall be two-way design with 12" low frequency drivers and 1" high frequency driver/horn combination.

- 2. Each loudspeaker shall provide the following features:
  - a. Protection Steel ball gaurds over cone drivers
  - b. Frequency Response/Sensitivity 90Hz-16KHz, +/-3dB)
  - c. Power Rating 200W continuous pink noise
  - d. Dimensions 23.9" x 15.4" x 14.3"
  - e. Weight 38.4 lbs.
  - f. Dispersion 90 deg x 60 deg @ -6dB
  - g. Mounting integral mounting points on cabinet rear for mounting brackets
- 3. Acceptable products, provide two:
  - a. Community Veris 2-12-96
  - b. JBL Eon 1500
  - c. Electro-Voice SX100+
- K. Equipment Cabinet:

1. The rack shall be a section wall-mounted cabinet constructed of 16 gauge CRS throughout. The rear section and front door shall be hinged to the center section. The hinges shall be bolted not welded.

- 2. Each section shall be one-piece construction with M.I.G. welded joints and seams.
- 3. The rear section shall have concentric 1/2" and 3/4" knockouts at the top and bottom.
- 4. The equipment mounting rails shall be tapped with 10-32 holes at EIA 19" rack spacing.

5. The front door shall allow 2" of distance from the mounting rails when closed. A cylinder lock shall be provided. Provide six keys to the owner.

- 6. Acceptable products, provide one:
  - a. Atlas/Soundolier 320-26B.
  - b. Middle Atlantic SWR18-16 with WRD-10 door.
  - c. Lowell L53-28.
- 7. Include one (1) Furman PL8 Pro Power Conditioner or comparable product by Surge X or Monster for each rack.
- 8. Provide one (1) Atlas SD7-145 Four Space Storage Drawer or comparable product by Middle Atlantic or Lowell.
- L. Hearing Assistance System:
  - 1. Provide a professional inductive hearing loop for use with receivers and t-coil equipped hearing aids.
  - 2. Acceptable products, provide as noted:
    - a. ILD 500 Professional Audio Loop Drive, provide 1
    - b. LP-IL-1 Hearing Loop Receiver with Lanyard Package, provide 10
    - c. Contractor must have Listen Level 1 Hearing Loop certification

#### 2.2 CAFETERIA SOUND EQUIPMENT:

A. FM Wireless Microphone System:

1. The Wireless Microphone shall be a miniature battery-operated FM transmitter and matching AC powered receiver incorporating compander circuitry to increase dynamic range and signal-tonoise ratio. The systemshall operate in the UHF band, utilizing dual diversity antennae for reducing multipath problems. A backlit LCD display shall show the operating frequency, antenna signal strength and transmitter battery life. An auto-detect mode shall allow the receiver to synchronize with the matng transmitter.

- 2. Each system shall incorporate agile frequency tuning and shall be able to operate with up to
- 12 wireless systems simultaneously.
- 3. Minimum Overall Performance Requirements:
  - a. Frequency Response: 45-15,000 Hz,  $\pm 2$  dB (without mic).
  - b. Distortion: 0.5% THD.
  - c. Dynamic Range: >100dB, A weighted.
  - d. RF Carrier Frequency: 518-752 MHz.
  - e. Frequency Sensitivity: -105dBm for 12dB SINAD
- 4. Hand-Held Transmitter, provide two:
  - a. Hand-held microphone with built-in transmitter, batteries, and antenna.
  - b. LCD display showing frequency and battery life.
  - c. Power Output: 30mW RF using 2 AA batteries.
  - d. Acceptable Products:
    - 1) Sennheiser SKM135G2 with mating swivel stand adapter.
    - 2) Shure SLX2/SM58 with mating swivel stand adapter.
- 5. Receiver, provide two:
  - a. AC powered receiver in <sup>1</sup>/<sub>2</sub> rack package with dual antennas.
  - b. A backlit LCD displaying frequency, RF signal and transmitter battery life. .
  - c. Balanced microphone and line-level output on rear panel.
  - d. Provide two remote 1/4 wave antennas and mounts per receiver
  - e. Acceptable Products:
    - 1) Sennheiser EM100G2/NT with rack mount.
    - 2) Shure SLX4 with rack mount.
- B. General Purpose Microphone:
  - 1. Usable in floor or desk stand using included clip.
  - 2. Hyper-cardioid or super-cardioid directional characteristic.
  - 3. 15 dB or greater front-to-back discrimination from 100-8000 Hz.
  - 4. Frequency response  $\pm 3 \text{ dB}$  from 120-12kHz.
  - 5. Provide with two 25' braided shield mic cable and cast zinc alloy connectors per microphone.
    - 6. Acceptable products, provide two:
    - a. Shure Beta 58M.
    - b. Sennheiser e845..
    - c. EV RE16.
- C. Microphone Stands:

1. Floor stand with 10" diameter cast iron base. Two-section extendible tube of 7/8" and 5/8" seamless steel tubing. Standard 5/8"-27 thread, adjustable from 37-60 inches in height. Black tube and base. Provide two Atlas MS-12CE microphone stand.

D. Microphone Mixer:

1. The mixer shall be have eight (8) mic/line channels. Each input shall have a dedicated front panel level control.

- 2. A master level control, bass and treble tone controls shall be provided.
- 3. The output section shall deliver +22dBV at less than 0.009% THD.
  - 4. Acceptable product, provide one:
  - a. Rolls RM-82.

b. Approved equal by Peavey or Rane with a minimum of the above stated features and performance.

- D. Power Amplifier:
  - 1. Solid-state, two channel amplifier. Capable of withstanding +22dBu input.
  - 2. Front panel indication of clipping.
  - 3. All inputs via barrier type terminal strips, Phoenix or XLR-type connectors. All outputs via barrier type terminal strips or 5-way binding posts.
  - 4. Minimum Performance Requirements:
    - a. Frequency Response: ± 1 dB, 20-20,000 Hz.
    - b. Distortion: 0.003W THD, 20-20.000 Hz at 10% below full rated output.
    - c. Signal to Noise Ratio: 100 dB below rated 8 ohm output 20Hz 20kHz.
    - d. Inputs: min. 20k, balancedI
    - e. Minimum Rated Load Impedance: 4 ohms, able to operate safely into any load.
  - 5. Output Power:
  - 300W per channel minimum into 8 ohms.
  - 6. Acceptable Products, provide one:
    - a. QSC CMX500V
    - b. Crown CDi1000
    - c. Approved equal by Ashly
- E. CD Player/iPod Dock
  - 1. Provide a rack-mount stereo CD Player with built-in iPod dock and infrared remote control.
  - 2. Integrated unbalanced analog and digital outputs.
  - 3. Acceptable products, provide one:
  - c. Tascam CD200i
  - d. No other CD Players will be acceptable.
- F. Programmable Dual DSP Processor:

1. Tamper-resistant unit without front panel controls, with on-board non-volatile memory for multiple presets, field programmable internally with security code lockout, or by external device.

2. Minimum requirements are: two input channels; two output channels;1/3 octave-band analog cut/boost filters on ANSI preferred 31.5-16,000 Hz center frequencies; automatic feedback suppressor, input signal delays; output signal delays; compressor/limiters; and programmable gain settings.

- 3. Programming of settings using personal computer running Windows 98 minimum.
- 4. Dimensions: 1-3/4" high for standard 19" rack-mounting.
- 5. Minimum Performance Requirements:
  - a. Frequency Response:  $\pm 0.5$  dB, 20-20,000 Hz. with controls set for flat response.
  - b. Distortion: 0.003% THD typical at +4dBu, 1kHz, odB gain.
  - c. Dynamic Range: >107dB, unweighted.
- 6. Programmable Dual DSP Processor-Acceptable Products:
  - a. dbx Drive Rack 220i
  - b. Shure DFR22.
- G. Power Amplifier:
  - 1. Solid-state, two channel amplifier. Capable of withstanding +22dBu input.
  - 2. Front panel indication of clipping.

3. All inputs via barrier type terminal strips, Phoenix or XLR-type connectors. All outputs via barrier type terminal strips or 5-way binding posts.

- 4. Minimum Performance Requirements:
  - a. Frequency Response:  $\pm 1 \text{ dB}$ , 20-20,000 Hz.
  - b. Distortion: 0.003W THD, 20-20.000 Hz at 10% below full rated output.
  - c. Signal to Noise Ratio: 100 dB below rated 8 ohm output 20Hz 20kHz.
  - d. Inputs: min. 20k, balancedI
  - e. Minimum Rated Load Impedance: 4 ohms, able to operate safely into any load.

5. Output Power:

185W per channel minimum into 8 ohms.

- 6. Acceptable Products, provide one:
  - a. QSC CMX300V
  - b. Crown CDi1000
  - c. Approved equal by Ashly
- H. Loudspeakers . Provide and install at left and right of the stage proscenium
  - 1. The loudspeakers shall be two-way design with 12" low frequency drivers and 1" high fre-
  - quency driver/horn combination.
  - 2. Each loudspeaker shall provide the following features:
    - a. Protection Steel ball gaurds over cone drivers
    - b. Frequency Response/Sensitivity 90Hz-16KHz, +/-3dB)
    - c. Power Rating 200W continuous pink noise
    - d. Dimensions 23.9" x 15.4" x 14.3"
    - e. Weight 38.4 lbs.
    - f. Dispersion 90 deg x 60 deg @ -6dB
    - g. Mounting integral mounting points on cabinet rear for mounting brackets
  - 3. Acceptable products, provide two:
    - a. Community Veris 2-12-96
    - b. JBL Eon 1500
    - c. Electro-Voice SX100+
- I. Equipment Cabinet:

1. The rack shall be a section wall-mounted cabinet constructed of 16 gauge CRS throughout. The rear section and front door shall be hinged to the center section. The hinges shall be bolted not welded.

- 2. Each section shall be one-piece construction with M.I.G. welded joints and seams.
- 3. The rear section shall have concentric 1/2" and 3/4" knockouts at the top and bottom.
- 4. The equipment mounting rails shall be tapped with 10-32 holes at EIA 19" rack spacing.

5. The front door shall allow 2" of distance from the mounting rails when closed. A cylinder lock shall be provided. Provide six keys to the owner.

- 5. Acceptable products, provide one:
  - 1. Atlas/Soundolier 320-26B.
  - 2. Middle Atlantic SWR18-16 with WRD-10 door.
  - 3. Lowell L53-28.
- J. Hearing Assistance System:
  - 3. Provide a professional inductive hearing loop for use with receivers and t-coil equipped hearing aids.
  - 4. Acceptable products, provide as noted:
    - a. ILD 500 Professional Audio Loop Drive, provide 1
    - b. LP-IL-1 Hearing Loop Receiver with Lanyard Package, provide 10
    - c. Contractor must have Listen Level 1 Hearing Loop certification

## 2.3 WIRE

- A. Provide West Penn 291, or equal, for all microphone jack, line jacks and remote volume control locations, and for all line level wiring. Color code wires for separate functions (e.g. blue=microphone, violet=line level, green=volume).
- B. Provide West Penn 226, or equal, for the Cafeteria and Gymnasium loudspeaker cluster circuits and hearing loops.
- C. Provide West Penn 225, or equal, for the Cafeteria loudspeaker circuits.

# 2.4 CONNECTORS

- A. Provide Neutrik NC3 series "XLR", Neutrik NP3C "TRS" or Canare F-09 "RCA" connectors for microphone and line level connections
- B. Provide Switchcraft N112B connectors for line inputs.
- C. Provide crimped or gas-tight terminals for all loudspeaker connections. Wirenuts are not acceptable.

# 2.5 MUSIC REPRODUCTION SYSTEMS

- A. Music Reproduction Systems: Each music reproduction system shall be equipped with an accessible connector/plate assembly, suitable for connection to an Owner provided stereo system. Provide in each room one (1) wall-mounted loudspeaker stereo connector plate assembly. Stereo connector plateshall be stainless steel and the connectors shall be push-to-connect, spring-loaded wire retainer type, suitable for connection to a stereo system. Color-code the positive and negative connectors. Provide 16AWG stranded pair cable, West Penn #225/25225 or approved equal, for connection between loudspeakers and connector plate assembly. Refer to contract drawings for device locations and any additional electronic hardware and/or configuration requirements for the local music reproduction systems.
- B. Provide self amplified powered wall mounted loudspeakers for auxillary line input from wall plate. Loudspeakers shall be furnished in Architect's choice of black or off-white finish. Loudspeakers shall be rated at 200 watts continuous, 800 watts peak, be equipped with a 12" low-frequency driver and a high-frequency driver with 65 x 65 degree constant directivity horn. Minimum loudspeaker frequency response shall be from 55Hz to 20kHz with a minimum sensitivity rating at 1watt/1meter of 98dB. Provide each wall-mounted loudspeaker with one (1) color-matched Omni-mount WB-60.0, or approved equal, ball/socket pivot bracket; configured for bottom mount and through bolted to loudspeaker enclosure. Attach brackets to wall structure according to manufacturer's instructions. Provide Electro-Voice ELX series, Apogee APL or approved equal.

## PART 3 - EXECUTION

3.1 INSTALLATION

- A. Maintain a competent supervisor and supporting technical personnel during the entire installation. Change of supervision during the project is not acceptable without prior approval from the owner.
- B. All equipment, except portable equipment, shall be held firmly in place. This shall include loudspeakers, projection equipment, cables, rack enclosures, etc. All switches, connectors, cable, etc. shall be clearly, logically and permanently marked during installation. Markings shall be engraved directly on the required surface, or on "grav-o-ply" plastic, or hot-stamped on heatshrink. Cabling inside equipment racks and large surface raceway shall be secured at six (6)- inch intervals. Wiring shall be carried out according to the standards found in Sound System Engineering by Don & Carolyn Davis (Howard W.Sams and Co., catalog #21857).
- C. The Contractor shall be responsible for mounting and installing of all equipment specified herein. All conduit and hardware related to the conduit (i.e. boxes, supports, blank plates, etc.) shall be provided by others. All wire to support the Sound system, except AC power wire, shall be fully installed (pulled and terminated) by the Sound Contractor.
- D. The equipment racks shall be fully assembled and tested in the contractors shop prior to delivery to the site. All wires that come into the equipment rack shall be terminated on barrier strips or quick-connect termination blocks specifically designed for stranded wire. Telephone-type 66 blocks shall not be acceptable for termination of stranded wire. Wires entering the equipment racks shall not connect directly to any equipment.
- E. Install the wires entering the equipment racks in such a way as to allow re-adjustment of the rack location by the user. Use Cole-Flex XS100-type expandable braid sleeving around each bundle of signal wires and furnish six (6) foot loops that will rest off the floor when the rack is not pulled out into the room. Assure adequate strain relief of all wires.
- F. Install different signal types in separate conduits. Run and bundle wire types in groups allowing separation of at least 12 inches between types. Do not run any signal wires in parallel to AC power cabling. Signal and AC power wires shall only meet and cross at right angles to each other. Coordinate with the Electrical Contractor to have conduits of like signal types grouped at Sound junction boxes, or run signal types separately in divided surface raceway between Sound junction boxes and the equipment racks.
- G. Install the loudspeakers as depicted in the drawings. Follow the manufacturer's recommendations for rigging and support structures. The Contractor shall gasket each under-balcony baffle to prevent rattling and resonance between the ceiling and speaker assembly. Pull speaker circuits through separate conduit from microphone or line level circuits.
- H. Install microphone outlets as shown on the drawings. Wire all cables pin for pin with: shield on pin 1, hot or red on pin 2, and cold or black on pin 3. The outlet shall be a Soundolier S-501 with Switchcraft C3F, or equals. Pull microphone circuits

through separate conduit from speaker or line level circuits. All microphone circuits shall be home run lines without splices.

- I. Install remote volume controls as shown on the drawings. Do not splice wires, parallel connections only on approved terminal strips in enclosures or by neat and orderly soldering on connectors.
- J. Fill all blank spaces in the equipment cabinet with panels of appropriate size. Provide security covers for all equalizers, delays, and other non-user preset controls.
- K. Where multiple hearing assistance systems are installed (i.e., Cafeteria, Gymnasiums, Auditorium, etc.) then it shall be the Contractors responsibility to consult and co-ordinate with the Engineer for the appropriate channels for simultaneous system operation without interference between hearing assistance systems. It shall be the Contractor's responsibility to provide all equipment, such as transformers, preamps, power supplies and other materials for a complete and functioning system, whether or not is enumerated on the plans or in the specifications.
- L. Provide ADA compliant notification plaque at each main public entrance(s) to rooms equipped with a hearing assistance system. Plaque(s) shall be adequately sized and mounted at heights per ADA requirements and contain a standard "hearing assistance available here" graphic in English and Spanish text and accompanying Braille. Contractor to coordinate notification plaques with Architect for foreground/background color and font.
- M. Furnish and install all materials, devices, components, and equipment required for complete, operational systems.
  - 1. Rack Equipment installation:
    - a) Wire each rack as a unit to self-contained terminal strips.
    - b) Install all rack mounted equipment, devices, and materials in equipment rack in a logical, functional manner, demonstrative of signal flow within the respective system arranged for easy accessibility and convenient maintenance.
    - c) Utilize existing Equipment Racks including retaining devices and protective covers for run sheets, elevation and single-line drawing.
    - d) Run all microphone and line level wiring in the equipment racks on the equipment input side of the rack and all AC control, and speaker wiring on the output side of the rack.
    - e) Install a full height outlet strip with not less than ten outlets ready to be served by its own branch circuit via a fourplex receptacle box at the base of the equipment rack.
    - f) Provide a separate ground lead from each amplifier chassis and from each of the other items of equipment normally requiring grounding to the rack ground bus.
    - g) Connect rack ground bus to isolated grounding buss by a single, green !12 TW stranded wire.
    - h) Shielded cables shall be grounded exclusively to isolated grounding bus.

- i) Ground cable shields via a single path, tie to isolated grounding buss.
- j) Signal Ground provisions shall realize less than 0.15 ohms to the primary ground connection.
- 2 Cluster Installation Procedures:
  - a) Provide and install positioning and support elements for loudspeaker assemblies where required. All such provisions shall be attached to and be wholly contained within the areas designated.
  - b) Arrange all cluster positioning and support devices so that the positioning of each loudspeaker assembly is independently adjustable in both the horizontal and vertical planes. Support elements for each of the loudspeaker cluster components shall be independent and designed with a live load safety factor of at least five (5).
  - c) Verify that no cluster component or other loudspeaker assembly is subjected to stress, abrasion, or loading effects which could contribute to extraordinary failure.
  - d) Eliminate all conditions causing noise, rattle, or other extraneous sounds resulting from the operation of a loudspeaker assembly under any operation condition.
  - e) Provide protective, capacitors in series with each directly driven high frequency loudspeaker component.
- 3 System Checking and Equalization
  - a) Preliminary checks and testing shall be conducted by the Sound Contractor prior to performance testing. Such procedures shall verify and insure proper operation of all components, devices, or equipment, nominal signal levels within the system, and the absence of extraneous or degraded signals. Preliminary checks shall include verification or the following:
    - (1) Proper grounding of devices and equipment. Proper provision of power to devices and equipment.
    - (2) Integrity of all insulation, shield terminations and connections.
    - (3) Integrity of soldered connections.
    - (4) Absence of solder splatter, solder bridges, debris of any kind, tools, etc...
    - (5) Integrity of signal and electrical system ground connections.
    - (6) "Wire Checking" of all circuitry, including phase and continuity of all audio system distribution lines, with reference to running sheets, cable designation and submittal drawings.
    - (7) Sound contractor shall determine the proper sequence of energizing the system to minimize risk of damage to any components.
    - (8) After successfully energizing the system, the Sound Contractor shall make all preliminary adjustments, documenting the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, and device gains and losses, as applicable. All data shall be tabulated along with an inventory of test equipment, a description of testing conditions, and a list of test personnel.

(9) The Sound Contractor shall measure and record the unequalled or "raw" curve at no less than three sites in the reverberant field.

## 3.2 GROUNDING

- A. Provide equipment grounding connections for Integrated Telecommunications/Time/Audio/Media System as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
- B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.
- C. The contractor shall provide all necessary transient protection on the AC power feed and on all station lines leaving or entering the building.
- D. The contractor shall note in his drawing, the type and locations of these protection devices as well as all wiring information.
- E. The contractor shall furnish and install a dedicated, isolated earth ground from the central equipment rack and bond to the incoming electrical service ground buss bar.

## 3.3 SYSTEM PERFORMANCE TESTS

A. Provide all required testing apparatus to complete the performance test of the system. Provide knowledgeable personnel to perform the testing.

B. Provide the following minimum test equipment:

1. Audio Toolbox or Audio Control SA-3050A with calibrated microphone and printer output options.

- 2. TEF 12+ or TEF 20 TDS analyzer or Audio Precision P1A.
- 3. Earthworks M30 microphone and preamplifier.
- 4. Sennheiser ZP-3 or Goldline ZM1 AC impedance bridge
- 5. HP 8903BDistortion analyzer
- 6. Oscilloscope
- 7. Sound level meter
- 8. Digital Multimeter

C. Measure and record the DC loop resistance of all microphone lines with a shorting plug installed in place of the microphone.

D. Check and correct the phasing of all loudspeakers.

E. Measure and record the impedance of all loudspeakers including the connecting wires. The values may be checked with the impedance meter but, the measurements shall made and recorded with the TEF analyzer, as recommended by the manufacturer, from 20 Hz to 20,000 Hz.

F. Measure and record the THD and noise level of each amplifier channel. Load the output with 8 ohm power resistors. Adjust controls for optimum signal-to-noise ratio and full amplifier output with a -50 dBm, 1 kHz sine wave at one microphone input. Measure and record the distortion level; the level shall be less than 1%. Substitute a 150 ohm resistor at the microphone input and measure and record the overall hum and noise at each amplifier output. The level shall be down at least 80 dB from the full output level from 20 Hz - 20,000 Hz.

G. Check for oscillation and radio frequency pickup. Set up system for intended usage, less any microphones. Use an oscilloscope on the speaker lines to monitor the output of the system. Insure that the system is free of spurious oscillation and RF pickup with no input signal and when driven to 75 dBA with a 500 Hz sine wave.

H. Check for and correct any rattles or buzzes. Apply a full range music source adjusted so that peaks are at specified minimum sound pressure level. Apply a swept sine wave from 100 Hz - 2,000 Hz at the specified average sound pressure level. There shall be no irregularities.

I. Adjust system levels so the limiter/compressor (or the mixer's integral limiter) activates just before clipping of any and all amplifiers. The limiter shall be turned "OFF" for all other tests. Reactivate and recheck the limiter after all other tests have been completed.

J. Adjust the digital delay line to a setting that provides the best time coherence between the visual source, speaker systems and hearing assistance system.

K. Measure and record, on the chart recorder, from at least three (3) representative positions, the "RAW" frequency response of the voice speaker system alone, without equalization. Repeat the above procedure for the program speaker system.

L. Equalize, measure and record the "EQUALIZED" frequency response of just the speaker system from at least three positions. The response shall be  $\Box 3 \text{ dB}$  of the following:

- 1. Flat and even between 100 and 5,000 Hz.
- 2. Fast rolloff (about 12dB per octave) below 50 Hz.
- 3. Slow rolloff (about 3dB per octave) between 5,000 and 10,000 Hz.
- 4. Fast rolloff (about 6-12dB per octave) beyond 15,000 Hz.

M. Measure the maximum output level of the system. Apply full range music adjusted so that peaks remain below the clipping level of the amplifiers. Measure the output level at peaks with the "fast" setting on the SLM. The audio system shall be able to deliver at least 105 dBA SPL to any audience position in the Gymnasium and 95dBA SPL in the Cafeteria.

## 3.3 DOCUMENTATION

- A. Provide a DVD and a printed copy of all field programming for all components in system.
- B. Provide a DVD and one copy of all diagnostic software with copy of field program for each unit.
- C. Provide a DVD and one copy of all service manuals, parts list, and internal wiring diagrams of each component of system.

D. Provide a DVD and a one print copy of all field wiring runs, location and end designation of system.

#### 3.4 WARRANTY

A. Provide a two (2) year warranty from date of final acceptance by Owner.

# **END OF SECTION**

# SECTION 27 15 00 - VOICE OVER INTERNET PROTOCOL (VoIP) AND DATA SYSTEMS

## PART 1 – GENERAL

## 1.1 GENERAL:

- A. The General Conditions, any supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this section as fully as if herein. Questions regarding these specifications should be directed to the Supervisor of Technology Support.
- B. These terms and specifications are to serve as a companion to general educational specifications for computer networks for new construction and blueprints describing the design of the computer network. All references in this document will not applicable to all renovation projects. Prior to installation of the computer network, the successful bidder must meet with the FCPS Supervisor of Network Infrastructure and Classroom Support Services to determine the specifics or modifications on a given project. We require a single vendor solution for all aspects of the installation for all schools. The successful bidder will be required to perform all of the following:
- C. All work in this section shall be completed by the computer network contractor except for installation of the network switches, WAN equipment and servers. This will be completed by FCPS or a suitable installer. The computer network installer shall be on the list of pre-qualified cabling contractors and shall be approved by the Frederick County Board of Education.

## 1.2 TECHNICAL SUBMITTALS:

- A. Original specification sheets or clear copies of same shall be submitted on all items. Manufacturers name, make and model number shall appear on each sheet. Submittals shall be bound in booklet form with cover sheet and index, and presented in a neat and logical order in a binder. Submittals shall contain installation, operation and programming manuals of the system to provide the Owner and Engineer complete information as to system features, functions and capabilities.
- B. Submit product data on each product specified in this section, including, but not limited to the cabinets and cabinet components, cabling, and cabling components, rack hardware and accessories, patch cord organizers and cable ring wiring path blocks, fiber optic cable, multipair telephone cable, Category 6 UTP cable, cable end connectors, wireways, cable management, surge protectors, conduit, and other raceways and associated components, jacks, etc., in a bound, jacketed loose-leaf binder. Provide five (5) copies of the specification data. Each item proposed should be tagged with a star, an arrow, etc.
- C. Submit dimensional drawings as identified in section 2.19 Engineering.
- D. Submittal shall contain a complete schedule of manufacturer's part numbers and quantity listings of all supplied components.
- E. Submit Shop Drawings of each proposed system (Voice/Data) indicating the proposed system configuration and all specified requirements. Shop Drawing shall indicate proposed cable

routing, detail installation locations of equipment, cable quantities, cable types, and terminal block locations. All Shop Drawings shall be Contractor's original drawings. Submission of Engineer's Contract Drawings as Shop Drawings is not permitted. A detailed set of floor plans for the complete building shall be furnished showing the locations of *all* equipment and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. The layout of all telecommunications system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.

- F. Manufacturer's model and catalog numbers, which are given for convenience of identifications only, change frequently and may not necessarily include specified or required features and may not insure compatibility with supporting systems or intended application. Contractor shall insure that material and equipment delivered to job site is suitable for the intended application and indicated connections. Review of shop drawings shall not include review and verification of submitted catalog numbers or quantities required.
- G. Review of and noted comments on Contractor's submitted shop drawings do not constitute a change order or a waiver of contract requirements. In the event of conflict between submittals or shop drawings and contract documents, the latter shall govern. If Contractor requests waiver of a particular requirement, a formal written request shall be made to Owner as per General Conditions and requirements published elsewhere.
- H. When directed, the Contractor shall provide samples of material or equipment.

# 1.3 SCOPE OF WORK:

- A. The successful bidder shall furnish all labor, materials, equipment, software tools, and service necessary for, incidental to, installation and testing of data cable and equipment for a building-wide network. The data network is to be a Category 6 star topology with a 10gigabit Ethernet fiber optic backbone between the main wiring closet and all sub-closets. The network cabling shall be capable of providing 1000BaseT Ethernet to the network outlet. Every network outlet is to have its own "homerun" connection to the modular patch panel in the wire closet. The total number of network outlets varies from one school to the next. No network cable runs are to exceed 300 feet (90 meters). All eight wires are to be terminated to support gigabit transfer rates the 568B wiring pattern. AMP is the preferred brand of cable, patch panels, plates and data jacks. However, equivalent materials are acceptable. The determination of equivalence will be made by FCPS Technology Services staff. For each project, funds will be set aside for the purchase of FCPS system standard network switches, WAN equipment, telephone equipment and servers.
- B. The successful bidder shall be responsible for providing detailed as-built drawings of all network designs to Frederick County Public Schools (FCPS) Technology Services. Blueprints are available in the FCPS Facilities Department, 7446 Hayward Rd.
- C. Category 6 (plenum rated when necessary) cable to be installed and terminated to RJ-45 Category 6 computer network outlets. Provide three (3) network outlets (one voice & two data) in the front of the room near the teaching station and at least four elsewhere (in groups of two) in each classroom. Provide a single drop in the ceiling for connectivity to a projector and one drop in the ceiling for connectivity to a ceiling mounted wireless access point. Provide network outlets for offices, various labs and work areas as indicated on the project

blueprints. Any storage space larger than 100 square feet should also have at least three network outlets (one for voice and two for data.

- D. The local area network is to include all components for a fully functioning network utilizing most current version of SNMP management protocols. Network to include, but not limited to: faceplates, RJ-45 connectors, cabling, 110 modular patch panels, all of which will support Category 6 standards. The network will also include equipment racks and all network electronics including, managed Ethernet switches, and routers.
- E. Cable to support Category 6 transmission must meet EIA/TIA 568B standards. Only those products that actually bear the Underwriter's Laboratories (UL) marking will be permitted.
- F. The structured cabling system shall consist of any or all of the following subsystems:

Data Network Subsystem Media subsystem\* \*specified in a separate document Backbone subsystem Equipment room subsystem

- G. The proposed system shall cover its capacity and functionality with minimum components and be flexible and capable of supporting new facilities and technologies as they become required or available.
- H. The wire closet components shall accommodate all network outlets detailed on the blueprints.
- I. The fiber optic network must include twelve (12) strands of single mode fiber between the MDF and the demarq and eighteen (18) strands of multimode fiber between the MDF and each IDF. All fiber must support 10gigabit throughput.

## 1.4 GENERAL CONDITIONS:

- A. The successful bidder shall expect that contractors from other trades may be working in the building at the same time or that the school is in session while this contract is in progress. The successful bidder shall fully cooperate with all those working in the building. Work shall be done as described in the General Conditions. The successful bidder shall assume that ceilings will be in place prior to this work and that the successful bidder shall be held responsible for damage to any existing ceiling tiles.
- B. The successful bidder shall meet with the appointed representative of FCPS Facilities Department prior to the start of installation work, to determine phasing and timing of planned installation. Prior to starting the installation, the assigned supervisor or lead technician, shall participate in a walk-thru of the project with FCPS staff (including a representative of the Technology Services Division to review the engineering/installation documentation and verify all installation methods and cable routes.
- C. The successful bidder shall be responsible for completing a standardized report form addressing the weekly progress of the installation schedule.
- D. The successful bidder shall examine the site and observe the conditions under which the work will be done or other circumstances which will affect the work <u>before submitting his bid</u>. No subsequent allowance will be made for errors or omissions in connection with this examination.

- E. Where there exists a conflict between Drawings and Specifications, the Engineer shall be contacted to determine the intent. In all circumstances, the final Contract Document interpretation shall provide compliance with all codes.
- F. All work shall conform to the requirements of the authorities having jurisdiction over this work and latest editions of the following codes, regulations, manuals, and specifications:
  - 1. National Electrical Code (NFPA-70 or latest revision)
  - 2. National Electric Safety Code
  - 3. Underwriter's Laboratories
  - 4. Applicable Codes of Frederick County, Maryland
  - 5. National Fire Protection Association
  - 6. B.O.C.A.
  - 7. FCC Regulations for Telephone Data Systems
  - 8. BICSI Methods Manual
  - 9. Electronics Industry Association (EIA)
  - 10. Telecommunications Industry Association (TIA)
    - i. TIA/EIA Standard 568B
    - ii. TIA/EIA Standard 569A
    - iii. TIA/EIA Standard 606A

If local regulations or codes are more stringent, then those stipulations shall govern. Contractor shall utilize any newer or superseded versions of the documents listed. In that situation, notification should be given to the FCPS Technology Services Division including how the installation will change relevant to the updated code/standard.

- G. The successful bidder shall obtain and pay for any and all certificates and permits required for the work to be performed.
- H. All materials and equipment shall be installed and completed in a high quality and workman like manner and in accordance with the best modern methods and practices. The successful bidder shall be certain that all installation work areas are secure and made safe in accordance with Occupational Safety and Health Administration (OSHA) regulations.
- I. Materials installed which do not present an orderly and reasonably neat or workman like appearance or are not installed in accordance with these specifications or the contract drawings shall be removed and replaced at successful bidder's expense when so directed by FCPS.
- J. If mention has been omitted herein of any items (installation tools) of the work or materials usually furnished for, or necessary to the completion of the cabling work (screws, anchors, clamps, tie wraps, distribution rings, miscellaneous grounding and support hardware) or if there are conflicting points in the specifications, FCPS attention should be called to such an item or items in sufficient time for a formal addendum to be issued. Any and all conflicting points in the specifications and/or drawings which are not questioned by the successful bidder and clarified prior to opening of bids shall be subject to the interpretation of FCPS after award of the contract, and its interpretation shall be binding upon the successful bidder.
- K. The successful bidder shall guarantee the complete cabling and network installation, as described in these specifications, free from all mechanical and electrical defects for the period

of three years, beginning from the day of final acceptance of the work by FCPS. The successful bidder shall also, during this guarantee period, be responsible for the proper adjustment of all systems, equipment and apparatus installed by him and do all work necessary to insure efficient and proper functioning of the systems and equipment. No charges shall be made by the successful bidder for any labor, equipment, materials or transportation during this period to maintain functions. However, the successful bidder shall not be held responsible for damage resulting from vandalism or acts of God. The successful bidder shall respond to trouble calls within forty-eight (48) hours after receipt of such call.

- L. The successful bidder shall not roll or store cable reels without an appropriate underlay.
- M. The contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.
- N. Outlets on electrical circuits to support the buildings computers or network switches should be color coded and not used for any other purpose.
- O. In schools and offices served by a backup power source such as a generator, all MDF's and IDF's must be served by this backup power with sufficient capacity to maintain all MDF & IDF equipment that provides voice connectivity.
- P. All wiring closets should be secure locations with locking doors (without glass).
- Q. The installation contractor shall mount any equipment or electronics as close to the wiring wall fields as possible, taking into consideration future growth, to facilitate administration and service.
- R. The successful bidder shall only use new materials.
- S. The successful bidder shall touch up scratched or marred surfaces to match the original surfaces.
- T. The successful bidder must have a BICSI RCDD project manager on staff and assigned to this project. Proof of active RCDD certification is required to be submitted. The successful bidder must have BICSI certified Installers and Technicians on staff and assigned to this project. Proof of BICSI Installer and Technician certifications are required to be submitted.

## PART 2 – PRODUCTS

#### 2.1 GENERAL:

- A. All computers and printers will be furnished by FCPS.
- B. The successful bidder will be responsible for preparing a database indicating the location of each network outlet and corresponding port on wire closet patch panel and network switch.

## 2.2 GROUNDING

- A. The successful bidder shall be responsible for providing an approved ground at all newly installed distribution frames and protector locations insuring proper bonding to existing facilities.
- B. The successful bidder shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, enclosures, cabinets, service boxes, racks and framework.
- C. All grounds shall consist of 6 AWG copper wire and shall be supplied from an approved building ground and bonded to the main electrical ground.
- D. Category 6 patch panels are to be UL certified to meet or exceed EIA/TIA specifications including SB 40 "worse case pair" requirements. DC resistance to be less than 100 milliohms.

#### 2.3 HORIZONTAL DATA SUBSYSTEMS

- A. Successful bidder shall supply a horizontal cable to connect each information outlet to the backbone subsystem on the same floor.
- B. The type of horizontal cables shall be 4-pair unshielded twisted pair (UTP). The UTP cable shall be 24 AWG solid copper conductors insulated with high-density plenum rated cover (when necessary) and twisted into pairs and conforms to EIA/TIA 568, TSB-36 and TSB-40 standards. Data cable shall be blue in color.
- C. One 4-pair UTP Category 6 cable shall be used for each network outlet.
- D. The 4-pair UTP shall be run using a star topology format from the termination block from the patch panel in the wiring closet for each section to each network outlet in that section.
- E. The length of each individual run of horizontal cable from the termination block in the wiring closet to the network outlet shall not exceed 300 feet (90 meters).
- F. The successful bidder shall observe the bending radius and pulling strength requirements of the 4-pair UTP during handling and installation.
- G. Each run of cable between the patch panel and the network outlet shall be continuous without any joints or splices.
- H. In existing structures, the successful bidder shall place distribution cabling following the same basic route of the existing wiring, except where conduits are full or the route is not easily accessible, or newly installed distribution media.
- I. In suspended ceiling areas where cable trays or conduit are not available, the successful bidder shall bundle station wiring with cable ties at appropriate distances. The cable bundling shall be supported via the existing building structure and framework, using bridal rings.
- J. Conduit runs installed by the successful bidder should not exceed 100 feet or contain more than two (2) 90 degree bends without utilizing appropriately sized pull boxes.

- K. The successful bidder shall conceal horizontal distribution wiring internally above ceiling, within walls and in Wiremold when cable must be installed on wall surfaces.
- L. The successful bidder shall be responsible for removing and reinstalling all ceiling tiles required for installation of the wiring.
- M. The cable shall be able to support voice, building services and data (EIA/TIA 568 Category 6 - 550 MHz up to and including gigabit per second throughput). Provide cables with full extended manufacturer's warranty.
- N. The 4-pair UTP cable shall be Underwriter's Laboratories (UL) listed CMP and CMR.
- O. Run cables above hung ceilings suspended from surfaces above with approved devices, or in cable trays, using convenient run sizes secured with properly tensioned cable ties. Comply with NFPA requirements for exposed cable. Route cable runs to clear electrical devices above ceilings by not less than twelve (12) inches.
- P. Where wire and cable penetrate walls or other structural elements of the building, install EMT sleeves sized to accept sizes of run, as follows:

IPS/Trade size	Number of Cables
0.75 inch	2
1.00 inch	4
1.25 inch	8
1.50 inch	11
2.00 inch	18
2.50 inch	27
3.00 inch	41
3.50 inch	55
4.00 inch	71

- Q. Where cables penetrating exceed specified capacity of a single sleeve, install multiple sleeves. Where sleeves penetrate fire-rated construction, install with fire-stopping. Size sleeves to accept number of cables in the run, plus 10 percent for future expansion.
- R. All horizontal cable runs should include a ten (10) foot service loop.

#### 2.4 HORIZONTAL VOICE SUBSYSTEMS:

FCPS will be utilizing a voice over IP telephone solution and therefore, the standards described for data will apply.

## 2.5 DATA BACKBONE SUBSYSTEM:

- A. The backbone subsystem shall include vertical runs for in-building cable between wiring closets. See Appendix B for design information.
- B. The successful bidder shall run the vertical cables in a star topology terminated in the main wiring closet at one end and in the IDF's at the other end.
- C. Successful bidder shall provide multi-core optical cables for the vertical cables. This cable shall be able to support voice, data and building service applications.
- D. The multi-core optical fiber cables shall consist of 18 strands of multi-mode 50/125 micrometer fibers per IDF capable of supporting 10 gigabit throughput.
- E. Each fiber shall be buffered with color-coded PVC.
- F. The fiber cable shall meet the NEC requirement for OFNR or OFNP and comply with Belicore, FDDI, EIA/TIA-568 and ICEA standards.
- G. The fiber cable shall meeting the following specifications:
  - 1. Maximum loss:
    - a. 3 dB/km at 850 nm
    - b. 1 dB/km at 1300 nm
  - 2. Minimum bandwidth:a. 1500 MHz/km at 850 nmb. 500 MHz/km at 1300 nm
- H. The fiber cable shall be UL listed.
- I. The fiber cable shall be plenum type when necessary, intended for use in return air relays and shall be terminated and labeled at both ends.
- J. The fiber cable shall be installed in an appropriate interduct or conduit.
- K. All fibers within a bundle should be properly terminated on both ends.
- L. In addition to the fiber cables, the successful bidder shall install four (4) Category 6 copper cables between the MDF and each IDF connected via the Cat 6 patch panels. It is understood that these may exceed the 90 meter limit for Cat 6.
- M. The MDF & all IDFs must have sufficient cooling capacity to handle expansion of the network hardware including additional servers in IDF's for specialty programs. All power supplied to the MDF & IDFs must be on generator backup.

## 2.6 COPPER BACKBONE - COPPER VERTICAL RISER CABLES

Successful bidder shall supply and install a 50-pair bundle of Category 6 cable to connect the MDF to each of the IDF's and to terminate in 110 blocks on each end.

## 2.7 NETWORK OUTLETS:

- A. All voice & data outlets supplied by the successful bidder shall be a modular universal application RJ-45 type. Jacks shall be ivory or white. Provide jacks as manufactured by AMP or another manufacturer with an equivalent product. Equivalency to be determined by FCPS Technology Services.
- B. The information outlet shall be either surface or flush mounted, quad port, screw fastened to the box. Outlets with friction connections will not be accepted. Plates shall have sufficient label spaces for each jack or each pair when four port plates are utilized. A raised plate is preferred. Plates shall be ivory or white to match the décor of the building. Provide plates as manufactured by AMP or another manufacturer with an equivalent product. Equivalency to be determined by FCPS Technology Services.
- C. The outlet shall meet or exceed the Category 6 (550 MHz) EIA/TIA-568B requirements.
- D. The information outlet shall be Underwriter's Laboratories (UL) listed and comply with FCC part 68.
- E. The information outlet shall be kept clean of any foreign materials (dust/paint) and shall be replaced or thoroughly cleaned if it becomes contaminated.

## 2.8 PATCH CABLES

- A. The type of patch cords shall be EIA/TIA-568-B compliant.
- B. Successful bidder shall supply factory assembled Category 6 patch cables to connect the computer workstations to the network outlets and to patch the network switches to the patch panel. All patch cables should have built-in strain relief and be blue in color. Total patch cords supplied should be equal to twice the number of network outlets. One-fourth should be ten (10) feet long, one-fourth should be seven (7) feet long, one-half should be one (1) foot long. In addition, the successful bidder shall provide forty (40) white patch cords; twenty should be five (5) feet long and twenty should be three (3) feet long.
- C. Successful bidder will supply factory assembled Category 6 patch cables to connect telephones to network outlets. These should be ten (10) feet long and light gray in color. The quantity should be equal to the number of installed telephones plus 20%. In addition, the successful bidder will provide an equal number of blue factory assembled Category 6 patch cables to patch telephone connections in wiring closets. These cables should be one (1) foot long.
- D. Fiber patch cords shall be used for optical fiber cross connects and interconnects.
- E. The fiber patch cords shall consist of two single, buffered graded-index fibers with 50 micrometer core and 125 micro-meter cladding.
- F. The fiber cladding shall be covered with aramid yarn and a jacket of flame-retardant PVC.

- G. The fiber patch cords shall be factory terminated with "SC" connector plugs on one end and "LC" connectors on the other and at least fifteen feet long. The number of cords shall be equal to the number of wiring closets times nine.
- H. The fiber patch cords shall meet the following specifications:
  - 1. Minimum bend radius: 1.25 inch
  - 2. Operating temperature: -20 to 70 degrees C
  - 3. Loss: 0.4 dB per mated connector (ceramic) and 0.5 dB per mated connector plastic

## 2.9 DATA BACKBONE SUBSYSTEM:

- A. The backbone subsystem shall include vertical runs for in-building cable between wiring closets.
- B. The successful bidder shall run the vertical cables in a star topology terminated in the main wiring closet at one end and in the IDF's at the other end.
- D. Successful bidder shall provide multi-core optical cables at the vertical cables. This cable shall be able to support voice, data and building service applications.
- E. The multi-core optical fiber cables shall consist of eighteen (18) strands of multi-mode 50/125 micro-meter fibers per IDF capable of providing 10 gigabit connectivity terminated with "SC" type connectors at both ends.
- F. Each fiber shall be buffered with color-coded PVC.
- G. The fiber cable shall meet the NEC requirement for OFNR or OFNP and comply with Belicore, FDDI, EIA/TIA-568 and ICEA standards.
- H. The fiber cable shall meeting the following specifications:
  - 1. Maximum loss:
    - a. 3 dB/km at 850 nm
    - b. 1 dB/km at 1300 nm
  - 2. Minimum bandwidth:
    - a. 1500 MHz/km at 850 nm
    - b. 500 MHz/km at 1300 nm
- I. The fiber cable shall be UL listed.
- J. The fiber cable shall be plenum type, intended for use in return air relays (if necessary per HVAC design) and shall be terminated and labeled at both ends.
- K. The fiber cable shall be installed in an appropriate interduct or conduit.
- L. All fibers within a bundle should be properly terminated on both ends.
- M. In addition to the fiber cables, the successful bidder shall install four (4) Category 6 copper cables between the MDF and each IDF.

- N. All school locations shall have a separate IDF to feed the front office admin area.
- O. Provide a 12-strand single mode fiber optic bundle from the main wire closet (MDF) to the school's CATV demarcation point as indicated on the plans. This fiber must be capable of supporting 10G Ethernet. If the demarcation is not located, for budgetary purposes, the contractor shall include 500 feet of 12-strand, single mode fiber installed from the MDF to the CATV demarcation point and terminated with "SC" connectors on both ends. The CATV demarcation will be located in the field.
- 2.10 NETWORK SWITCHES
  - A. FCPS will provide all needed network electronics.
- 2.11 ROUTER
  - A. FCPS will provide all needed WAN equipment.
- 2.12 FILE SERVERS
  - A. FCPS will provide all main file servers and related network backup.
- 2.13 TELEPHONE EQUIPMENT
  - A. Telephone handsets and switch equipment will be provided by FCPS.

#### 2.14 WIRELESS INFRASTRUCTURE

- A. Wireless LAN equipment and installation will be provided by FCPS.
- 2.15 UNINTERRUPTIBLE POWER SUPPLY PROVISIONS:
  - A. The contractor shall make space provisions at the bottom of each rack for an FCPS furnished UPS and external battery. Contractor shall install FCPS furnished UPS & battery unit.
  - B. Contractor shall be responsible for coordinating the electrical receptacle mounting on the data rack.

#### 2.16 EQUIPMENT ROOM SUBSYSTEM:

- A. The Contractor shall provide 3/4" deep fire-retardant-treated plywood backboard(s) at each data equipment rack. Plywood backboards shall be painted white (or other finish color as selected by Owner) with durable enamel paint. Plywood backboards shall conform to Product Standard PS1, Grade B-D, with one finish smooth side (Class A surface). Minimum size shall be 4 feet wide x 8 feet high.
- B. At locations where generators are installed, the MDF and all IDF's shall be supported by the generator with sufficient connectivity such that all network switches can be maintained by the generator.

## 2.17 RJ-45 PATCH PANEL:

- A. Provide Category 6 (550 MHz) patch panels as shown on the drawings. Patch panels shall be 48 port RJ-45 with Type 110 punch-down blocks on the rear, 568B wiring pattern, rack mountable.
- B. Shall be manufactured by AMP or another manufacturer with an equivalent product. FCPS Technology Services will make the final determination of equivalency.

## 2.18 FIBER OPTIC PATCH PANELS:

- A. Fiber Optic Patch panels shall be rack mounted and shall be capable of terminating 12-96 fibers as designated on the drawings. All fiber connectors shall be "SC" type single or multimode as noted on the drawings.
- B. Fiber Optic Patch panels shall permit the use of pre-terminated or on-site terminated fiber optic cables. Cables shall be managed using the included retaining clips. The enclosure shall be of aluminum construction and shall have a clear Lexan door and the rear panel shall have hinged aluminum door for access.

## 2.19 CABLE MANAGEMENT

A. All racks should have appropriate horizontal and vertical cable management equipment (front and back). See Appendix C & D for sample rack layout diagrams for cost estimating purposes. All items identified on the diagrams as being installed by the vendor are to be provided by the vendor. The exact rack layout will be reviewed at the pre-installation meeting with FCPS Technology Services Division.

## 2.20 ENGINEERING

- A. An initial planning meeting will be held with the successful bidder to clarify all requirements (systems, services, distribution methods, etc.), identify responsibilities, and schedule the events that will transpire during the implementation of the project. Within two weeks of notification to proceed, the successful bidder shall provide a written report and project schedule to clearly document the events and responsibilities associated with the project. Thereafter, the FCPS Technology Services Department will meet weekly on-site with the successful bidder for progress updates.
- B. Frederick County Public Schools will review the engineering documentation within two (2) weeks of receipt. If no revisions are required, the documentation shall be formally accepted in writing by FCPS. Any revisions shall be completed by the successful bidder within two (2) weeks and resubmitted for review.
- C. The final engineering diagrams and documentation shall include two "D" size (24 inch x 36 inch) copies of the items listed below:
  - 1. Riser Distribution Plan
  - 2. Layout of all Distribution Frames, including front elevation and specification on all equipment with the racks including patch panels, UPS, switches and cable management equipment.

- 3. Floor plan with labeled outlets and cable routing
- 4. Equipment room plans
- 5. Work area floor plans
- 6. Building control plans
- D. In addition to the engineering diagrams, the following items shall be provided by the successful bidder:
  - 1. Laser printer generated cable assignments.

#### 2.21 EQUIPMENT RACKS

- A. Racks used to house network electronics and patch panels at MDF's and IDF's shall be floor mounted 19 inch x 84 inch two-post racks and shall be complete with all equipment mounting hardware except where indicated in design plans. Racks shall be constructed of steel or extruded aluminum and capable of supporting 600 pounds and shall be open Type B universal mounting rail hole pattern. Racks shall be attached to the floor with appropriate sized lag screws. Top of the racks shall be supported to the cable tray or the wall if no cable tray is to be provided. Contractor will provide two racks in the server closet of four-post design for servers, tape backup systems and other heavy equipment. This is in addition to racks required for network cabling and equipment. Contractor will provide at least thirty (30) appropriate equipment mounting screws for each rack for network electronics.
- B. IDFs providing connectivity to specialized computer labs such as computer science, computer graphics, and technology education will also require a four post rack for servers with a UPS as described above and rack mount power strip.
- C. Wall mounted racks are permitted only where a very limited number (less than 25) of data and/or telephone ports will be connected. Those locations are indicated on drawings. Design shall be swing-frame to permit easy access. The rack shall accept standard EIA 19 inch wide rack equipment. The rack shall be sized to be capable of housing the equipment indicated including switches, patch panels and cable management equipment with at least twelve (12) 1.75 inch spare unused mounting spaces at the bottom of the rack. Final rack layouts will be discussed with FCPS Technology Services at the pre-installation meeting.
- D. Where the drawing requires an enclosure, the enclosure shall be black and have removable locking access panels on the side and rear for easy access. There shall be a hinged, lockable door on the front. A thermostatically controlled ventilation fan shall be provided.
- E. Provide at least two 10-outlet rack mounted power strip with on-off switch and power indicator light per rack.
- F. Wire closet equipment racks shall conform to EIA Standard RS-310C for 19 inch x 84 inch racks. The main server closet should have two racks that are a four post variety for the server, backup drive and communications equipment in addition to the two post racks needed for patch panels, network switches, etc. Racks in all IDF's should be floor mounted, two post construction unless otherwise noted on drawings.
- G. Suitable power outlets needs to be provided at the rack for connection to all UPS equipment. There should be at least two (2) 20 amp circuits per rack in all closets. These circuits should be connected to the building generator. The MDF at the high school level requires at least

eight (8) 20 amp circuits with an Edison duplex outlet per circuit. These should be mounted in such a way as to provide power to UPS equipment without using extension cords. The MDF must have sufficient cooling for all of the network and voice communications as well as routing equipment and multiple servers.

H. A four post rack with must be provided in all IDFs which provide network connectivity to any specialized computer labs such as technology education, computer science, computer graphics, digital photography, music, etc. These rack will be used to house servers and any other network equipment specific to that instructional program. This rack must have a UPS as described in 2.15 above as well as a single rack mounted power strip with at least eight (8) outlets. These closets will also need additional cooling capacity.

# PART 3 – EXECUTION

## 3.1 CABLING:

- A. Cables run exposed above accessible ceilings shall be run in bundles of a size convenient for the successful bidder for easiest installation and must meet NFPA requirements for exposed cable. Bundle by use of cable ties, taking care not to cinch cables. Where cable trays are not provided, cable ties shall be supported by rings supported from braces, joists, and other structural members. In no case shall cable be supported from below by contact with the ceiling system.
- B. Label all category 6 cables and ports as well as fiber optic cables.

## 3.2 CUTTING:

- A. The closing of superfluous openings and the removal of all debris caused by said work under this contract shall be performed by and at the expense of the successful bidder.
- B. All surfaces disturbed as a result of such cutting shall be restored to match original work and all materials used for patching, mending, or finishing shall conform to the class of materials originally installed. Material Safety Data Sheets (MSDS) must be submitted to the Manager of Maintenance and Operations, prior to work beginning, listing solvent, paints, finishes, etc. to be used. The successful bidder shall plug conduits and entrance holes where cabling has been installed by the installation contractor in the main equipment room, manholes, riser, and other cable entrance locations with re-enterable duct seal or flame retardant putty.
- C. Wherever any roofing and/or waterproofing is pierced, such work shall be done and opening shall be sealed absolutely watertight by experienced water-proofers and shall be included in he guarantee hereinafter mentioned.
- D. Any and all roof penetrations shall require a submittal and approval of details for work by the Manager of Maintenance and Operations. Where warranted roofing is involved the roofing manufacturers approval of the detail submittal may be required.
- E. If the MC/MDF, IC/BDF, or TC/IDF hardware is wall mounted, it shall be the responsibility of the successful bidder to equip the entire wall surface with retardant plywood sheets. The plywood sheet shall be 8 feet x 4 feet x 0.75 inches and shall be

mounted vertically several inches above the floor level. The plywood shall be painted to customer specifications.

## 3.3 FOREMAN

A. A competent foreman shall be on the premises at all times to check, layout, coordinate and supervise the installation.

## 3.4 BIDDER

- A. The successful bidder shall give consideration to the work of other trades and prevent interference in the location conduits, sleeves, cables, and other equipment. Cable location should not interfere with installation, operation or maintenance of network or non-network equipment. The successful bidder shall maintain a work area free of debris, trash, empty cable reels, scrap wire, etc. and dispose of such items on a daily basis.
- B. The successful bidder shall insure that the maximum pulling tensions of the specified distribution cables are not exceeded at any time during the placement of the facilities. Failure to follow the appropriate guidelines may require the contractor to provide the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the installation contractor during the implementation.
- C. The successful bidder shall maintain the twist in all twisted pair cable up to the point of termination as required in the industry standard specifications for Category 6 cable.

## 3.5 LOCATION SHIFT OF OUTLETS

A. A reasonable shifting in location of Computer Network Outlets (NO's), within the same room in any direction, shall be expected in order to meet field conditions and this work shall be done at no increased cost to Owner.

## 3.6 DESIGN DRAWING PRINTS

A. A separate set of clean, neat network design drawing prints shall be kept at the site at all times during the installation for the express purpose of showing any and all changes made. The prints shall be marked up daily showing any rerouting of cables, additional network outlets, or any changes whatsoever. The prints shall be marked in a neat, legible manner. At the completion and final acceptance of the project, the complete set of As-Built drawings shall be delivered to Facilities, Construction and Renovation Department, Frederick County Public Schools, 7630 Hayward Road, Frederick, MD 21701, via written transmittal.

## 3.7 CABLES

A. The cables shall be placed at least six (6) inches away from parallel running electrical cables. They shall not route closer than twelve (12) inches to any electrical fixtures and

they shall cross electrical cables at a 90 degree angle.

# 3.8 LABELING OF COMPUTER NETWORK CABLING, FACE PLATES AND PATCH PANELS:

- A. All computer network cabling must be labeled on each end of the cable run. Labeling shall be machine printed permanent plastic tape wrapped around each end. The labels shall be placed around the cable sheath at both ends, within three inches of the end of the sheath.
- B. All wiring closets should be numbered starting with one (1) for the MDF. The first IDF will be IDF 2. This number should be clearly identified in the closet as well as on all asbuilt drawings. In addition, there must be a plate outside of the door indicating the closet number. Example: IDF 3. All wiring closets should have a building diagram indicating closet designations and locations.
- C. The cable label should include the following:
  - 1. Wire Closet # (1, 2, 3, etc)
  - 2. Rack # within the closet (1, 2, 3, etc starting from the left facing the racks)
  - 3. Patch Panel Letter Designation (A, B, C, etc (starting from the top and working down)
  - 4. Port # on the patch panel
  - 5. Room #
  - 6. Network Drop # within the room (1, 2, 3, etc) beginning with the drops just inside the door to the left and working clockwise around the room and at the top/upper left on the plate and working left to right on top than left to right on the bottom.

For example, 2-1-B-35-312-2

## 3.9 CONNECTOR IDENTIFICATION NUMBERING SYSTEM:

A. Each Computer Network Outlet in all classrooms, offices, etc. will be labeled with a permanent machine-made marking scheme with an identification as per the design below. Labels should be printed black on while with printing as large as will fit in the labeling space. See Appendix A for examples of the required labeling scheme for connector face plates and patch panel labels.

## 3.10 WARRANTIES:

- A. Successful bidder shall provide a one (1) year passive product warranty, backed by the manufacturer, and a three year application assurance warranty on applications described in this document, from the date of successful commissioning.
- B. Contract is for full maintenance (parts & labor), support, or replacement of all network
components for a period of three years from date of acceptance by FCPS.

C. System shall be installed using a single vendor so as to provide full long-term (minimum 20 years) manufacturers warranty for cable, jacks, plates, etc.

# 3.11 TESTING THE SYSTEM:

- A. General Acceptance Requirements All "as-built" and technical documentation shall be received and approved by the Owner, all intra-building wiring and equipment and all site restoration shall be installed and completed in accordance with Frederick County Public Schools and industry standards. All wiring and equipment provided and/or installed must be operational.
- B. Copper Cable Plant Testing Testing shall diagnose the presence of all open-loop conductors, grounded, shorted or crossed conductors, Db loss and split connections. <u>All pairs shall be tested</u> for continuity, and shall be certified free of all appreciable AC or DC voltages. The successful bidder shall perform all tests on all pairs installed (including spares), including but not limited to riser, ties, and stations. All cabling shall be checked utilizing a time domain reflectometer (TDR) to measure exact lengths of installed cable and for purposes of certifying the cable installation. All cables must be certified to meet Category 6 standards. Complete testing and correction reports shall be provided prior to acceptance. FCPS shall have final approval for the format used for recording and reporting test results. Testing to be completed by a 3<sup>rd</sup> party designated by FCPS using suitable test equipment. 3<sup>rd</sup> party testing must be re-done as needed until all drops meet specifications.
- C. Fiber Optic Testing and Certification There are four basic types of fiber optic field-testing required for acceptance of this project:
  - 1. Continuity testing
  - 2. Insertion loss testing
  - 3. Fiber Optic Time Domain Reflectometer (OTDR) testing
  - 4. Bandwidth testing
- D. Fiber Testing Continuity testing will be required to be performed on all fibers prior to installation to insure that the cable has not been damaged during shipment. A statement signed by the technician performing this test shall be sufficient documentation. Complete testing and correction reports shall be provided prior to acceptance. FCPS shall have final approval for the format used for recording and reporting test results. Testing to be completed by a 3<sup>rd</sup> party designated by FCPS using suitable test equipment.
- E. OTDR testing using a bare fiber adapter operating at 850nm shall be performed on all fibers, prior to installation, to ensure that the cable has not been damaged during shipment. Strip chart recordings or photographs of this test shall be required as a portion of the documentation. Post-installation (with connectors) testing Insertion loss testing

shall be performed on every fiber end to end link (including all splices, fiber and connector insertion loss). Post installation OTDR testing shall be performed on all fibers at both 850 nm and 1300 nm wave lengths to provide the following documentation:

- 1. Evaluate fiber loss per unit distance (dB/km)
- 2. Distance to localized attenuation splices, connectors and fiber ends shall be measured.
- 3. Verify quality of installed fiber connectors.
- 4. Bi-directional OTDR splice/connector loss measurements shall be done to provide the most accurate splice loss measurements.
- 5. As part of the documentation, OTDR generated reports shall be provided for each fiber tested for proof of performance.

A fiber optic test report shall be provided that will verify 100% compliance to all test requirements stated in this specification. Complete testing and correction reports shall be provided prior to acceptance. FCPS shall have final approval for the format used for recording and reporting test results.

- E. 100% of all installed copper and fiber optic cables including any spares, shall be tested and certified. Any cabling that does not meet described industry standards shall be removed and replaced with new cables which test fully functional within the specified industry requirements. The only exception are the copper tie lines between the MDF and IDF's and in that case, are accepted if the failure is due only to the distance exceeding cabling limitations.
- F. All test equipment must meet industry requirements for certification of the medium being tested and calibrated to factory standards.

## 3.12 AS-BUILT DOCUMENTATION:

- A. Intra building Wiring the successful bidder shall provide the following information for the data/voice/video network prior to acceptance of the contract:
  - 1. Cable penetration details.
  - 2. Location and identification of all distribution closets and of all equipment located inside distribution closets
  - 3. Terminal information, jack numbering, and pair county information at each distribution frame
  - 4. Schematic drawings of riser system
  - 5. Routing of cable and termination information.
- B. Cable Assignment Records The Successful bidder shall provide a complete listing of pair assignment records for copper wiring. Copper cable records shall include the status of each copper pair.
- C. Technical Documentation The Successful bidder shall provide the Owner with the

operational and maintenance documentation of all communications system equipment installed under this contract.

- D. Test reports for all cable tested, including Category 6 conformance, shall be provided to the Owner, as shown through pair scanner printouts.
- E. At the completion of the project, the system wiring diagrams shall be brought fully up to date with the actual field installation, showing all field made changes .' or deviations from the approved shop drawings. Accurately record location of service entrance conduit, termination backboards and cabinets, outlet boxes, messenger cable raceways and cable trays, pull boxes and equipment. Room names and numbers shall be up-dated to indicate actual field assigned room numbers. They may not necessarily be the room names and numbers shown on the contract drawings.
- F. Three (3) copies of the up-dated shop drawings and as-built wiring diagrams shall be provided to the owner.
- G. In addition to the copies provided in the manuals, copies of the Autocad Version 12.0 files on compact disc (CD).

# 3.13 CUSTOMER ACCEPTANCE

- A. At the conclusion of the installation a preliminary walk-thru with the successful bidder will be performed to check for installation quality, accurate performance of the work, and to verify engineering diagrams. Any modifications to the documentation or the installation that may be required shall be accomplished within a two (2) week period. "Customer Acceptance" shall consist of a final walk-thru with the successful bidder. The walk-thru shall be scheduled within three (3) weeks of the completion of the installation in order to turn the project and documentation over to Frederick County Public Schools. Please note that "Customer Acceptance" does not release the installation successful bidder from repairing any cabling errors or improperly labeled circuits, caused by the installation successful bidder, that may be discovered at a later date.
- B. The system shall be physically inspected by a representative of FCPS to assure that all equipment is installed in a neat and workmanlike manner as called for by the plans and specifications. Schedule inspections with Supervisor of Technology Support.

# 3.14 ACCEPTANCE BIDDER

- A. Only low-voltage contractors who have been pre-qualified by the Technology Services and Purchasing Department will be permitted. To be added to the pre-qualified list, you must complete an application and be approved. Contact the FCPS Purchasing department at 301-644-5209 for more information.
- B. The successful bidder must provide references including name, address and telephone

number of prior projects where the low-voltage contractor has satisfactorily installed networks of a similar size and complexity in other schools.

- C. The successful bidder shall provide a list of their technical staff along with their work experience and certifications. This is required of any sub-contractors as well.
- D. <u>All Low voltage installers</u> must be factory trained on the products they are installing to insure maximum manufacturer's warranty and must be able to provide documents to that affect.
- E. Successful bidder shall state their nearest branch office and dealer's office in relation to the proposed site of the structured building cabling system. If none, the location of the main office shall be stated.
- F. Successful bidder shall list all sub-contractor's and provide information for each subcontractor. Information must be submitted with the proposal and is due at time of bid opening. We retain the right to request a substitution if in our opinion the subcontractor is not qualified. If an acceptable sub cannot be identified, we reserve the right to reject the bid.

# **END OF SECTION**

# **APPENDIX A – Network Outlet & Patch Panel Labels**



# Classroom/Office Drop Layout

# **APPENDIX B – Fiber Optic Design**

NOTE: Each IDF should have 18 strands of 50/125 multimode fiber capable of supporting 10Gb throughput.



# **APPENDIX C – Two Post Layout**



3

# **APPENDIX D – Four Post Layout**

NOTE: All items identified as Vendor Installed shall be provided by the successful bidder.



Contractor Copy

(END OF SECTION)

## SECTION 27 51 23 - INTEGRATED TELECOMMUNICATIONS SYSTEM

#### PART 1 - GENERAL REQUIREMENTS

#### 1.1 GENERAL:

A. The conditions of the General Contract (General, Supplementary, and other Conditions) and the General Requirements are hereby made a part of this Section.

B. All bids shall be based on the performance and execution of the system as specified herein. The specifying authority must approve all systems.

C. This section covers the Intercommunication & Public Address System, and a Master Clock System. The Owner (FCPS) will furnish the Intercommunication / Public Address headend equipment and cabinet (only). The contractor shall install all Owner furnished equipment. The contractor shall provide all speakers, cabling, conduits, clocks, rough-in, boxes, terminations, labeling, testing and all other items specified to provide a complete and operational system.

D. Provide all labor, material, equipment, programming software, and services necessary for and incidental to the complete installation of the Intercommunication, Public Address and Master Clock System as described herein. The entire System shall be hereinafter referred to as IPC System or simply System. This complete System shall include all handsets and station wiring.

E. All work under this section is subject to the General Conditions and any Special Requirements for the entire Contract.

F. The installation shall conform to all rules, regulations and codes of local, state and federal authorities having jurisdiction including the National Electrical Code, National Fire Protection Association and NECA - Standards of Installation.

G. The Contractor shall be responsible for coordinating the telephone system with the Owner that the planned telephone system and capacity has not changed and is not being changed from the initial design.

H. Arrange conduit, raceways, backboards and equipment generally as shown. The Contract Drawings are diagrammatic and do not show all fittings, elbows, junction boxes, sleeves, etc., required for a complete installation. Provide all such devices as needed or as required to present a neat and fully functional system.

I. Where variances occur between drawings and Specifications or within either document itself, provide the item or arrangement of better quality, higher cost and/or neater installation. The Engineer will make all final decisions required.

J. Cabling shall be installed in cable tray, where practicable. All cabling shall be in conduit from cable tray to devices. Cabling installation practices for the IPC shall be identical to the practices and standards outlined in Section 271500: Data Systems.

## 1.2 SCOPE OF WORK:

A. Furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating integrated Communication System consisting of integrated

Telephone/Intercommunication, Public Address System, Audio Retrieval, and Time Control System as specified herein (IPC). The Owner (FCPS) will furnish the Intercommunication / Public Address headend equipment and cabinet (only). The contractor shall install all Owner furnished equipment. The contractor shall provide all speakers, cabling, conduits, clocks, rough-in, boxes, terminations, labeling, testing and all other items specified to provide a complete and operational system.

B. The owner, in conjunction with information provided by the contractor/equipment supplier, shall arrange telephone service with public utilities.

C. Where applicable, visit the site, verify all existing items shown on the plans, or specified, and be familiar with the working conditions, hazards, and local requirements involved; submission of bids shall be deemed evidence of such visit. All proposals shall take these existing conditions into consideration and the lack of specific information on the drawings shall not relieve the Contractor of any responsibility.

D. All materials, unless otherwise specified, shall be new, free from any defects, and of the best quality of their respective kinds. All like materials used shall be of the same manufacture, model, and quality, unless otherwise specified.

E. All manufactured articles, material, and equipment shall be applied, installed, connected, erected, used, protected, cleaned, adjusted, and conditioned as recommended by the manufacturers, or as indicated in their published literature, unless specifically herein specified to the contrary.

F. All work shall be performed by competent workmen and executed in a neat and workmanlike manner providing a thorough and complete installation. Work shall be properly protected during construction, including the shielding of soft or fragile materials and protection from dust and water spray. At completion, the installation shall be thoroughly cleaned and all tools, equipment, obstructions, or debris present as a result of this portion of work shall be removed from the premises.

# 1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. The work in this section is related to the work specified in the following sections: Section 16010 --General Provisions. Refer to Section 271500: Data Systems for additional cable plant compatibility requirements.

# 1.4 SUBMITTALS:

A. Original Specification Sheets shall be submitted on all items. Extensive use of photocopies shall not be acceptable. Incomplete specification sheets shall not be accepted. Manufacturers name, make and model number shall appear on each sheet. Submittals shall be indexed and presented in a neat and logical order. Submittals shall contain installation, operation and programming manuals to provide the Owner information as to system features, functions and capabilities.

B. Submit outline drawing of system control cabinets showing relative position and size of all major components. Submittal shall contain quantities of all supplied components. Detail equipment assemblies, rack elevations, indicate dimensions, weights, required clearances, and locations of each field location.

C. Submit FCC registration number on separate documentation with the ringer equivalency of the proposed integrated telecommunication system. This documentation is mandatory; all submittals without FCC registration information will automatically be rejected.

D. Submit wiring diagrams showing typical connections for all equipment. Detail wiring for power, signal, and control systems and differentiate between manufacturer=s installed and field-installed wiring. Identify terminals to facility installation, operation, and maintenance. Include a single-line diagram showing cabling interconnection of components. Provide a riser diagram for the system showing in technically accurate detail all connections, interconnections, and all provisions available and made for adaptability of all specified future functions and including all calculations, charts, and test data necessary to demonstrate that all systems and system components deliver the specified signals, grades, and levels at all required points and locations.

E. Shop Drawings: Submit layout drawings of integrated Communication System, components, and accessories. List all rooms and areas connected to the system. Submit IPC loudspeaker zoning plan along with all other IPC connection drawings for the facility; i.e. secondary clocks, local sound systems, staff telephones, etc.

F. Specification sheets shall be submitted on all items including cable types.

G. Submit a certificate of completion of installation and service training from the system manufacturer. The supplying contractor shall have attended the manufacturer's installation and service school. A certificate of this training shall be provided with the Contractor's submittal.

H. Product Certificates: Signed by Manufacturers of equipment certifying that products furnished comply with specified requirements.

I. Installer Certificates: Signed by Manufacturer certifying that installers comply with requirements.

J. Manufacturer Certificates: Signed by Manufacturers certifying that they comply with requirements.

K. Submit a copy of the UL listing card for the proposed system as specified in "Safety/Compliance" section of this specification.

L. Submittals not containing any of these documents shall be automatically rejected without further review.

M. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final matching transformer-tap settings, and signal ground-resistance measurement certified by the Installer.

N. Maintenance Data: For equipment to include in maintenance manuals specified in contract's General Provisions. Include record of Owner=s equipment-programming option decisions.

## 1.5 SERVICE AND MAINTENANCE:

A. The contractor shall provide a <u>three</u> (3) year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the owner during normal working hours. The warranty period shall begin on the date of acceptance by the owner/engineer.

B. Furnish service, maintenance, and labor of communications systems for three 3 years from Date of Substantial Completion.

C. The Contractor shall, at the Owner's request, make available a service contract offering continuing factory authorized service of this system after the initial 3 year warranty period.

D. The contractor shall maintain a local service center located within fifty (50) mile radius of the project. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system. The bidder supplying the equipment shall show satisfactory evidence that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to the system, including replacement parts. The bidder shall be prepared to offer a service contract for the maintenance of the system after the guarantee period. The bidder shall produce evidence that they have had a fully experienced and established service organization for at least five years and proven satisfactory installations during that time.

## 1.6 QUALITY ASSURANCE:

A. All items of equipment including wire and cable shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.

B. The Contractor shall be an established communications and Electronics Contractor that has had, and currently maintains, a locally run and operated business for at least ten (10) years. The contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty and training privileges.

C. The Contractor shall show satisfactory evidence that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The Contractor shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied. The Contractor shall provide a portable computer in order to record the programming required for the operation of the system. A separate disk shall be kept in the Contractor=s file that includes all of the programming information for this particular school installation. A separate programming information disk shall also be kept in the IPC main equipment rack for emergency field servicing.

D. Installer Qualifications: An experienced installer who is an authorized representative of the equipment manufacturer for both installation and maintenance of equipment required for this Section.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

- F. Comply with NFPA 70, National Electrical Code.
- G. Comply with UL 50, Enclosures for Electrical Equipment.
- H. Comply with EIA-160-51, ASound Systems@
- I. Comply with ANSI EIA-310-D-92 ACabinet, Racks, Panels, and Associated Equipment@.
- J. Comply with EIA-SE-101-A-49 AAmplifiers for Sound Equipment@.
- K. Comply with EIA-SE-103-49 ASpeakers for Sound Equipment@.
- 1.7 SINGLE SOURCE RESPONSIBILITY:

A. Except where specifically noted otherwise, all equipment supplied shall be the standard product of a single manufacturer of known reputation and experience in the industry. The Contractor shall have attended the Manufacturer's installation and service school and must show proof of attending such a school in the submission.

# 1.8 SAFETY / COMPLIANCE TESTING:

A. The communication system supplied shall be listed by Underwriter's Laboratories under UL Standard 1459. A copy of the UL listing card for the proposed system shall be included with the contractor's submittal. System shall be listed for direct connection to power and telephone utility services. Systems that do not carry the UL1459 listing shall not be acceptable. Submittals not containing the UL listing document shall be automatically rejected without further review.

B. The entire installation shall comply with all applicable and safety codes. All central equipment and additional applicable equipment shall be Listed by Underwriters' Laboratories, per U.S. requirements Note: Furnish an original, dated specimen of the test agency's listing card with the submittal.

1.9 IN-SERVICE TRAINING:

A. The Contractor shall provide, at no additional cost, a minimum of eight (8) hours of in-service training for the IPC system upon completion and acceptance of the installation. These sessions shall be broken into segments, which will facilitate the training of individuals in the operation of this system. The specified Operators' Manuals and Users= Guides shall be provided at the time of this training.

1.10 WIRING:

A. System wiring and equipment installation shall be in accordance with good engineering practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall test free from all grounds and shorts. IPC loudspeaker and equipment shall be installed per the practices and standards as set forth in Section 271500 Data Systems.

## 1.11 PROTECTION:

A. The Contractor shall provide all necessary transient surge protection on the AC power feed(s) to each equipment rack and on all loudspeaker, telephone station, central office lines and antenna leads leaving or entering the main building and portable classrooms (as applicable).

B. The Contractor shall include in the submittal and in the record drawings, the type and location of these protection devices as well as all wiring information.

# PART 2 - PRODUCTS

# 2.1 ACCEPTABLE MANUFACTURERS:

A. The Owner (FCPS) will furnish the Intercommunication / Public Address headend equipment and cabinet (only). The contractor shall install all Owner furnished equipment. The contractor shall provide all speakers, cabling, conduits, clocks, rough-in, boxes, terminations, labeling, testing and all other items specified to provide a complete and operational system. The communication system shall be installed by a sole source supplier of all systems specified herein The Owner and Engineer reserve the right to determine if an alternate manufacturer meets the requirements of the School and the intent of these specifications. Items and quantities are critical to the operation of the School and must be provided exactly as specified, no substitutions are allowed. Manufacturer and contractor shall also fully comply with the provisions outlined in these specifications.

B. The intent is to establish a standard of quality, function and features. It is the responsibility of the bidder to insure that the proposed product meets or exceeds every standard set forth in these specifications.

C. The functions and features specified are vital to the operation of this facility; therefore, the Contractor must provide full compliance with the requirements of this specification. Listing of a Manufacturer does not release the Manufacturer from providing all features and functions described herein.

D. Upon completion of the installation, the owner will review the installed system and compare to the minimum performance standards as set forth in these specifications. Any installed system not meeting the minimum standards of performance as set forth in these specifications will be removed by the providing contractor and replaced with a system referred to in these specifications as the "standard system of reference" at the expense of the contractor responsible for this section of the specifications. Any additional expenses incurred to meet the owner's interpretation of the "standard system of reference" will be the sole responsibility of the contractor responsible for this section of the specifications. Any delays in the schedule shall also be subject to liquidated damages as described in other sections of these specifications.

## 2.2 INTERNAL COMMUNICATIONS SYSTEM

The Owner (FCPS) will furnish the Intercommunication / Public Address headend equipment and A. cabinet. The contractor shall install all Owner furnished equipment. The Public Address System shall consist of a main and fully Central Control Unit, Consoles, interactive Graphical User Interface (IGUI) with interactive graphical representation of the school, separate web-based programming software utility for remote off-site programming and troubleshooting, rack, equipment and all other necessary devices that are required to create a complete and operational system such as Speakers, Horns, Amplifiers, and Visual Message Devices, where indicated on the plans, etc. All Public Address main equipment including card cages and all cards, power amplifiers, program sources, etc., shall be rack mounted in the MDF room. Fully and operational control unit shall be located as shown and or noted on plans. All system programming of Public Address and Master Clock features shall be accomplished by a Console located in the Main Office area or over the LAN/WAN or internet by a browser based software programming software utility. The browser based programming shall be separate from the interactive Graphical User Interface (IGUI) and shall not be accepted as a substitution of the interactive Graphical User Interface (IGUI). It shall not be necessary to attend to the main equipment in the Head End for normal day-to-day operation of the system. The system shall be a 25-Volt two-way paging system providing paging zones as indicated and determined by the Owner. The system shall be of modular design utilizing plug-in circuit cards to enable quick on-site replacement or addition of components for system expansion and modification including the conversion to IP when required or deemed more suitable for installation. The system head end equipment shall be rack-mounted in the MDF where shown on the drawings with side panels and stationary platform base. Provide shelves, doors, blank panels, AC power distribution, etc. as required to support all equipment and fill empty rack space. System shall be comprised of all solid-state electronics, utilizing a microprocessor-based central processor unit, power supplies, audio interface cards, control cards, input/output cards, telephone interface cards, transformers, paging amplifiers, etc., as required for a complete system, to include capability to interface with the Owner's VoIP telephone system. The interface must comply with loop-start central office (CO) trunk standards in North America as defined by Bellcore and/or industry-standard 2500 analog station ports. System provided for this project must be capable of IP communication platform regardless of relevance to this project. It is the intent of the owner to be able to

utilize IP communication to remote IDF's for future expansion. Any systems not capable or manufacturer's that have to provide a different model numbered system in the future in order to comply with IP communication capabilities are not considered convertible and shall not be acceptable for this project.

B. The system must include an interactive Graphical User Interface (IGUI) option software application that allows for the operation of the System from a Windows®-based PC. If separate and dedicated computer is required by the owner, provide networked PC, (coordinate location with Owner), keyboard, mouse, and 21" LCD Monitor. PC shall exceed manufacturer recommended specifications. This software package shall utilize an easy-to-use interactive Graphical User Interface (IGUI), quick and easy, graphically aided navigation access to all intercom functions, paging, and program distribution. The software shall also allow easy activation of class change schedules. Emergency operations shall be simplified through this software application by allowing stored audio files and alphanumeric messages for message displays to be activated from the IGUI. The IGUI shall allow common operations such as daily announcements to become automated, removing multistep console set ups and the dial strings. The means for originating voice communication to selected locations must be separate from IGUI application and must be provided through the system Console, Telephone Handset or Microphone. The software must allow the creation of a Custom Operating Screen (s) based on the floor plans of the school facilities. Icons representing Intercom Stations, and Paging, Monitoring and Audio Program Zones shall be incorporated onto the floor plans. The Software IGUI shall provide:

- 1. Simple Routine Call Processing
- 2. Emergency Functions
- 3. Paging
- 4. Audio Program Distribution
- 5. Enabling and Disabling of Schedules and Bell Scheduling
- 6. Customizable Page Elements
- 7. Customizable Operating Screen
- 8. Element Library for Emergency Event Icons

C. The IGUI must provide an efficient and reliable method of notifying the occupants within the facility of critical situations. A variety of emergency tone signals that reside within the Intercom/Paging System shall be activated by clicking on pre-programmed buttons on the IGUI screen, initiating the transmission of tone signals to speakers, and alphanumeric messages to Message Displays/Digital Clocks. A 'lockdown' icon shall be designed as per Owner direction, with owner selecting the appropriate tone. Whole building macros for emergency or off-normal response shall be built into the internal communication system as directed by the owner. Each macro shall be capable of being activated by the console, the IGUI or any remote button locations indicated on plans or as directed by the owner. It shall be possible to activate a WAV. file message, owner selected tone and coinciding English Language Message and distribute by zone as directed by the owner, all from a single activation Icon located on the IGUI. Other single action macros shall be activated in similar fashion via the IGUI and a custom labeled Icon. English language labeling of all Icons on the IGUI shall be user changeable. Systems that require the assistance or addition of a cheat-sheet for labeling and location of specific rooms, staff or bell schedule identification are contrary to the performance requirements of the owner and shall not be acceptable.

D. The main system shall include a head-end, a networked PC with Microsoft Windows XP or Vista running the IGUI software, a monitor, data entry keyboard, Administrative Control Console, serial connections to in-house alert systems, UPS power backup, Category 6 plenum rated structured cabling system with Patch Panels in IDF's, and all associated system components: The system shall allow for the connection of multiple devices per each station port. A station port is defined as a connection point for a typical classroom i.e.: combination of: call-in device(s) and a speaker(s) and a clock (including power and synch signal).

1. Direct dialing, two-way "amplified voice" communications between all locations equipped with Administrative Control Console, IGUI and/or telephone system handset, and all locations equipped with a public address system speaker; excluding corridor speakers. Must be capable of transmitting multiple, simultaneous amplified two-way voice and paging over the IP network.

2. An Administrative Control Console for facilitating all Public Address System announcements and programming, to include but not be limited to: Emergency all-call; paging zone and number assignments; call-in priority levels with tone characteristics; Master Clock event and tone signaling; monitor and reporting on call-in line faults; and manually distribute unique tones to all zones and speakers in the system.

3. The system shall provide for remote system diagnostics and access to activity log files on the system. The system shall also provide direct connect support for the IGUI program and integrate the functionality of an Administrative Control Console or PBX system phone into the framework of a PC. Audio files that are used for daily as well as emergency announcements and music files shall be retrievable by the IGUI interface.

4. Connection to a local building digital PBX or VoIP telephone system (phone system by Owner), allowing any telephone handset that is part of the telephone system to page and conduct hands-free, open-voice communication with any speaker in the system; the Administrative Control Console; IGUI or any other classroom telephone. The Connection to the local phone system shall not diminish or restrict any of the capabilities of local telephone system. Public Address System interfaces shall allow any programmed telephone to perform but not be limited to the following intercommunication system functions: all-call; zone call; intercom call to classroom speakers, distribute class change signals, etc. Caller ID information from Intercom must be transmitted and displayed on owner provide phone system phone displays.

5. User-programmable zone paging to all classroom and office speakers using any or all of the following: Microphone, Administrative Control Console, IGUI.

6. PBX system telephone integrated through the PBX to the internal communications head end. Public address zones shall be software programmable to include 1- and 2-digit numbers or English language labeling. Zone paging and program zones shall provide easy access to groups of zones or allzone pages.

7. Distribution of general announcements over School loudspeakers using a microphone, Administrative Control Console, IGUI, or telephone handset, on an All-Call basis, pre-selected zone basis, or multiple-zone basis to any paging zone. Speaker assignments to any zones shall be programmable from the Administrative Control Console or the remote programming software utility via the Web or WAN/LAN.

8. Distribution of emergency paging announcements over school loudspeakers using a microphone, Administrative Control Console, GUI or telephone handset. Emergency announcements shall have the highest priority over all other system functions, including the Local Audio Systems. Emergency announcements shall automatically disconnect and override all Local Audio Systems. Provide programming source to override local audio systems. Coordinate with 27 40 00 contractor.

9. Any individual room station within the system to be designated as a fixed zone by the simple entering of keystroke at the Administrative Control Console during a page selection. Selection and

monitoring of individual program sources (Microphone, AM/FM Tuner, Tape or CD) and distribution by the Administrative Control Console.

10. Programming of microphone for control and distribution of public announcements, to eliminate the need to go to the central electronics for microphone set up. Keying the microphone shall automatically mute all other audio programs at a lower priority in the system, including Local Audio Systems (emergency pages only). Microphone shall transmit to all rooms or specific speaker zones as programmed in the system software.

11. The capability of multiple open-voice intercom paths. Intercom paths shall be global. Systems which block multi-channel communication to more than one point on any card or interface in the system shall not be acceptable. Multiple amplified, open-voice intercom paths shall not be restricted over the IP network.

12. Automatic gain-control of intercom speech to assure constant speech level.

13. Automatic sounding of a warning tone over any loudspeaker selected for two-way communications to alert the classroom teacher to an incoming announcement.

14. Any system with more than one Main Administrative Control Console, shall also be provided with a minimum of two channels for intercom communications or audio program distribution. The System shall be user-programmable to allocate, upon demand, either of the two channels for intercom or audio program. Systems that only allow one channel per card or block multi-channel communication in any way shall not be acceptable. Systems that only allow one channel over distributed IP network shall also not be acceptable.

15. The ability to monitor the school building either on or off the premises from a single telephone.

16. Audio program distribution to a minimum of eight different areas of the building selected by the Administrative Control Console and Visual Console. Inputs shall be provided for five (5) low-impedance microphones, tuner, tape player and auxiliary source. Program material shall include audio programs from standard AM/FM tuner, tape deck, CD player, or auxiliary source. Administrative Control Console shall have the ability to monitor program sources being distributed. Coordinate location of antenna(e) with architect. Locate and install for optimal performance.

17. Audio Source equipment shall have the ability to be located remotely from the main system control electronics, and shall have the ability to distribute two channels of audio simultaneously if so desired. School shall be equipped with (1) rack-mounted AM/FM tuner, (1) rack-mounted cassette tape player, (1) rack-mounted CD player.

18. RS232, USB and RJ45 connection for Input/Output Interface shall be provided. Required use of serial converters for connection to LAN/WAN shall not be acceptable. Personal Computer, LAN/WAN, Modem, and Printer for monitoring activity within System and for displaying and printing system management information shall be capable of being utilized by system. System shall perform diagnostics, or logging transactions either on or off premises via browser or LAN/WAN. Communication via modem shall require a dedicated phone line and shall be provided at no cost to the owner. Any ongoing costs incurred to support modem communication shall be absorbed by the Electrical Contractor. Reliance on methods such as Remote Desktop connection for programming and troubleshooting shall not be acceptable.

19. The ability to interface to other systems such as Access Control, CCTV, Fire alarm or activation signal supplementation shall be required. Interface shall allow for automatic activation of emergency sequence messaging (Tone, WAV., Alpha/Text Messaging) through the internal communication system.

20. Time Signal tones of an integrated Master Clock System to be distributed throughout zone(s) selected for time signaling over programmed loudspeakers on a manual or automatic basis.

21. Power amplifiers that provide a minimum power capacity of 2 watts per cone speaker location and Door Signaling device plus 15 watts of power per horn type speaker locations.

22. Cabling that is specified by the manufacturer, which provides shielding of conductors so that the Internal Communication System does not interfere with the Telephone Systems and Telephone System cabling.

23. The system must be compatible with a structured cable plant with MDF and IDF and CAT6A cabling.

24. Classroom components (including a speaker, call-in device, clock power and) may all be connected to the system via a single CAT6 cable drop for each classroom/location to either the MDF or IDF in a Networked solution.

25. Pre-announce tones will alert the listeners of incoming calls with distinct tones for each priority level. To prevent unauthorized monitoring, the tone will sound whenever an area is being monitored, and will repeat at regular intervals. Facilities shall also be provided to defeat the tone repeat function from the console if it is not desired.

26. Emergency and All Call paging and a minimum of 32 zones of group paging. The paging zones shall be independent of the time tone and audio program distribution zones and a minimum of 8 messaging zones. Systems sharing zones for both paging and tone shall not be acceptable.

27. As per NEMA SB-40, Call-in device in the classroom will be in the form of a call switch and shall include a privacy option. The system shall be capable of call-switch supervision as well as the ability to install multiple, supervised call-switches in a single room without increasing the original wiring requirements of one pair for call-in. Multiple call switch installation shall allow for each switch to be programmed to call separate console locations and have separate priorities. Systems that require additional cabling for this feature shall not be accepted.

E. The system shall be capable of monitoring 32 different sections of the building, either on the premises from an Administrative Control Console, or off premises from a telephone instrument.

F. Distribution of paging announcements can be made from any Administrative Control Console, IGUI, telephone, or dedicated microphone set-up. Paging shall also be achieved by providing the capability to interface with existing premises phone system and displaying classroom caller ID information on the phone display regardless of the instrument utilized to initiate the call.

G. Emergency announcements shall have the highest priority over any other system function and seize all system loudspeakers regardless of their current mode of operation.

H. System shall support general announcements made from a conventional microphone to facilitate reading a script and the participation of multiple announcers. Keying the microphone shall automatically mute all other audio programs at a lower priority in the system and transmit the microphone audio to all buildings or specific speaker zones, as programmed into the system software.

I. System will provide Emergency and All Call Paging and a minimum of 32 zones of group paging. The paging zones shall be independent of the tone signal and audio program distribution zones.

J. Pre-announce tones will alert zones of incoming pages with distinct tones for each priority level.

K. The system must have the capability of distributing audio program sources from any authorized building telephone. Computer with interactive Graphical User Interface (IGUI) shall be provided. Systems that do not include an interactive Graphical User Interface (IGUI) shall not be accepted. Program distribution shall be accomplished on an all zone, selected zone, or individual zone basis.

L. The system shall support the automatic distribution of tone and text signals to all selected areas. Text messaging shall be displayed on digital LED display/clocks or LED displays. Messages shall be independent and or simultaneous. Messaging shall be pre-programmed or "on the fly".

M. The system shall support a minimum of 1536 events and 24 schedules. Building zones shall be used to select which areas receive the tone. They must be totally independent from page zones and program zones and clock messaging zones and shall be capable of a minimum of 18 simultaneous schedules

N. All system programming shall be accomplished through the master console, a network computer or from a PC utilizing a standard web browser.

O. The duration of the tone, as well as frequency, burst length and output level shall be software programmable from a web browser.

P. All system tones shall be user-programmable for the following durations in seconds: 2, 3.5, 5,6,8,10,12.

Q. The system shall be capable of an open-voice intercom path used for monitoring, emergency paging, and intercom.

R. If this project does not call for IP communication, the system provided shall contain the capability of converting to IP without the replacement of the system provided for this project.

S. Corridor speakers, and outside horns in each building shall be combined into groups of owner's preference. There must be 32 independent software paging zones that each circuit may be a part of. Each individual circuit must also have the ability to be paged independent of the software zones. Provide one high output station port per card with a minimum of 25 watts capacity.

T. All user-programmable data shall be stored in a non-volatile FLASH memory to prevent memory loss during a power failure. The system time clock shall be capable of maintaining correct time for a period of 14 days in the event of a power failure. It shall be possible to return the system programming to the original factory default setting by keying a special code from the Console. Any future software upgrades provided by the manufacturer shall be capable of being uploaded without the need to change CHIPS, Firmware or hardware.

U. The user shall have the capability to change system programming for all paging functions, bell functions, and clock functions. The Owner shall be provided with the required training, documentation, and software to accomplish these functions.

V. The system shall be connected to an (owner-provided) Ethernet network port using the TCP/IP protocol. Provide patch cord of sufficient length to connect the head end equipment to the owner provided network switch in the MDF for access to off-site remote programming and troubleshooting. Connection to the network shall be by standard RJ45 connection without the need for third party electronics or conversion. Systems that cannot provide an RJ45 connection to the network, without conversion shall not be acceptable.

W. The user-interface shall support user names and passwords. There shall be multiple levels of access allowed. Some users may have viewing privileges only while others may edit their site. All editing shall be by means of the programming software.

# 2.3 TELEPHONE INTERFACE

- A. System must provide the capability to interface and connection to the Owner's telephone system (Provided by Owner). Provide all equipment and cabling necessary to connect and integrate system to the phone system. Provide a minimum of 1 connection port.
- B. Each trunk shall be programmable as either incoming, or outgoing, or both.
- C. For incoming trunks, system shall be able to direct calls to a user-defined attendant telephone or provide dial tone. For outgoing trunks, system shall provide access to the trunk by dialing 8, 9, or both. If digit 9 is used to access an outgoing trunk, the system shall be able to automatically dial a second 9.
- D. Each trunk shall be loop start.
- E. Intercom contractor must coordinate telephone interface with Owner's telephone contractor.
- F. Caller ID information from classroom port shall be viewable on Owner's telephone.

## 2.4 INTERFACE WITH REMOTE SPEAKER SYSTEMS

1. The system will interface with remote audio systems located within the building.

## 2.5 CLASSROOM EQUIPMENT:

- A. Classrooms shall be equipped with the following minimum equipment as indicated on the drawings:
  - 1. Ceiling loudspeaker, baffle/support/back-box.
  - 2. Staff Telephone (supplied/installed by Owner).

## 2.6 ADMINISTRATIVE OFFICE EQUIPMENT:

A. Administrative Office areas shall be equipped with the following equipment or as indicated on the drawings:

- 1. A wall mounted digital display located in the main reception office area.
- 2. Administrative digital display telephones (supplied/installed by Owner).

- 3. A desktop emergency-paging microphone located in the main reception office area.
- 4. Ceiling loudspeaker, baffle/support/back-box and wall or ceiling volume control at locations indicated on the drawings.

## 2.7 PUBLIC ADDRESS / EMERGENCY TONE SIGNALING OPERATION:

A. The system shall provide for the distribution of paging announcements from any authorized telephone. It shall be possible to distribute announcements to the entire facility or to selected areas or zones. If the staff telephone originating a paging announcement is associated with a loudspeaker, the system shall automatically mute the speaker to avoid feedback.

B. The system shall provide the capability of assigning speaker locations to any one or more of at least eight (8) software programmable zones for zone paging. The paging zones shall be separate from time signal zones.

C. Through programming, it shall be possible to exclude selected speakers from the reception of paging announcements. Speakers may be permanently excluded or they may be temporarily excluded so that student testing or other functions may take place without interruption. Speakers that have been temporarily excluded shall be automatically reinstated by the system at midnight each night.

D. Provide a Priority Paging Microphone for use by administrative personnel located as indicated on the drawings. The microphone shall be a desk type with a locking Push-to-Talk bar. When the Push-to-Talk bar is pressed, the system shall automatically initiate a high priority all-page from the microphone.

E. The system shall provide for the distribution of emergency tone signals to all locations with speakers to alert school personnel to emergency situations. It shall be possible to initiate tone signals from any authorized telephone. When tones are initiated from a system telephone, it shall also be possible to make a voice announcement in conjunction with the tone. The system shall automatically mix the tone and voice signals.

F. The system shall provide for Personal Identification Numbers (PIN) for selected administrators. By dialing their PIN at any Owner's system telephone, the administrator shall have access to the same capabilities assigned to their office telephone including paging and tone distribution, regardless of the restrictions of the telephone they are currently using.

G. The system shall provide a minimum of three (3) separate paging amplifiers, of which each may be used independently and simultaneously for both paging and time-tone operations. It shall be possible to make at least three (3) zone pages simultaneously. Systems with less than three (3) simultaneous paging zones and three (3) paging amplifiers shall be considered unacceptable.

## 2.8 AUDIO PROGRAM RETRIEVAL OPERATION:

A. The system shall provide for the distribution and retrieval of audio programs. The system shall support up to three (3) simultaneous audio program sources.

B. The system shall be equipped program sources as follows: rack mounted AM/FM/MP3 player with monitor loudspeaker. The system shall be supplied with an exterior omni-directional AM and one FM antennae.

C. The system shall provide facilities for the distribution of program material from administrative locations in the following manner: Authorized administrative telephones may select a program source for distribution and then initiate the distribution to selected rooms, or zones or to all zones simultaneously.

## 2.10 MASTER CLOCK SYSTEM FUNCTIONS / OPERATION:

A. The system shall provide "State of the Art" Technology for Master Clock and Secondary Clocks, so that they form an integrated system together and with the Internal Communication System. Time programming shall be accomplished by way of a microprocessor-based and user-programmable master control system and shall be accessible from anywhere on the schools WAN/LAN. The system shall be easy to learn and operate. All standard system programming shall be user-friendly to allow the system administrator the ability to easily reprogram system features. Features offered by this system shall be implemented and controlled by software programs that can be changed and expanded as customer needs evolve. The Master Clock shall use an integrated master controller capable of operating and correcting both digital and analog secondary clocks as well as controlling class change signals to all speakers. The Master Clock systems shall provide the required signals to assure synchronization of all Secondary Clocks. Provide equipment and integration as necessary to utilize the master clock system as a network time source for the school LAN.

B. Master Clock System shall provide the ability to:

1. Provide automatic distribution of user-programmable time signals controlled from an integrated, 24-schedule, 1,024-event time clock. Time signal programming for 16 of the 24 schedules shall be available from programming software allowing remote access via the LAN/WAN or internet. Eight (8) of the 24 shall be available at the Administrative Control Console. Systems that do not provide an integral master clock capable of being remotely (LAN/WAN) programmed with system programming software shall not be acceptable.

2. Provide for program override to support manual distribution of class change time signals to all areas, or select groups of speakers from the Administrative Control Console or IGUI.

3. Transmit class change tones to selected areas of the school. Duration of the tone, as well as frequency and burst length and output level shall be software-programmable from the Administrative Control Console with 500 different combinations possible. User-programmable time signals shall be available to any of 16 time zones independent from paging and program zones.

4. Incorporate a built-in calendar with the capability to program in all holidays, and provide for automatic clock correction for Daylight Saving Time and Leap Year changes.

5. The unit will further permit programming, diagnostic, and activity logging through connection to an external computer.

6. Provide a 10-year battery back-up real time clock.

7. Battery back-up shall be provided to the Public Address/Intercom/Clock System, ensuring correct timekeeping of the Master Clock System during power failures. Once power is restored, the Master Clock shall instantaneously update all clocks with the correct time.

8. The built in Master Clock shall be capable of correcting analog secondary Clocks without the need for special hardware.

9. The ability to connect through the facilities Ethernet Network to obtain time synchronization from a Time Server.

10. The system shall have the capability of providing alpha-messaging as part of the time/tone schedules. The integrated Master Clock shall provide sixteen (24) user-programmable messages which may be activated as a part of the time/tone schedules, external relay, remotely located buttons, through the front panel of the unit or the IGUI. Messages displayed in the classrooms shall not interrupt the display of time at any time.

C. The Digital Calendar Clock shall be equal to the Telecor Model 2484 (Provide at main office.)

1. The Digital Calendar Clock shall simultaneously display the current time and date. The time shall be displayed in hours, minutes and seconds. Hours and minutes shall be displayed using 4.0" digits, and seconds shall be slightly smaller for easy distinction. The date shall be displayed in plain text using a 10-character dot-matrix display showing the day of the week, followed by the month and day.

2. All secondary clocks shall be continuously synchronized with the Master. Corrections shall be done instantaneously and all clocks shall display the identical time and date. In the event of a power failure, the system shall maintain proper timekeeping during the outage. Once power is restored, all clocks shall be immediately updated with the correct time and date.

3. The Digital Calendar Clocks shall utilize AlGaAs "Super-Bright" LED displays which shall offer exceptional visibility characteristics and shall be viewable from up to 120 feet away.

4. The Digital Calendar Clocks shall also be used to display messages in the dot matrix section of the display. These messages shall be used to alert personnel of an emergency or a situation of concern.

5. Messages shall be programmed using the Administrative Control Console or a computer via the LAN/WAN or internet and programming Software. The software shall utilize a user-friendly web interface designed for programming the system. Message data shall be transmitted from the system to all Digital Calendar Clocks on the network.

6. Messages shall be activated either manually or by scheduled event allowing text to be displayed at specific times and days of the week. Messages shall be displayed using a variety of visual effects, including scrolling or flashing single lines of text, as well as alternating between different lines of text.

7. The Digital Calendar Clock shall also be used as an ancillary visual enunciator to display emergency calls placed on the Internal Communications System. When an emergency call is placed, it shall be shown in the messaging area of the display until the call is cleared from the system. The dot matrix display shall default back to the date when not displaying messages. Indication of the Emergency Call shall be programmable as to which of the (minimum) 8 messaging zones it will be displayed.

8. The Digital Calendar Clocks in the hallways shall be capable of displaying an automatic countdown of remaining minutes between bells. When the class bell time is reached the hallway clocks shall revert to displaying the standard time or any messaging present.

9. The Digital Calendar Clock shall also be used as an elapsed digital timer, providing stopwatch functionality, indicating elapsed time on the six-digit display.

10. Elapsed timer functions shall include the ability to count upwards from zero to 24 hours, as well as counting down to zero from a specified value. The elapsed timer shall be controlled using a Timer Button Panel providing start, stop and reset functionality. When not operating as an elapsed timer, the clock shall default back to displaying the current time.

11. The clock bezel shall be anti-glare red with a smooth surface. No external screws or studs shall be visible on the bezel or clock housing.

- 12. The Digital Calendar Clock shall be recessed mounted. Provide the manufacturer recommended backbox to electrical subcontractor for installation.
- 13. Provide wire guards for all clocks in the gym. Wireguards shall be constructed of 3/32" diameter welded steel wire screen with 2" openings and 3/16" reinforced hoops. All joints are to be welded for strength and durability. The guards shall be finished in a rugged epoxy powder-coat finish, suitable for both indoor and outdoor environments.

D. The Analog Secondary Clocks shall be capable of receiving both the correction signal and correction (messaging) data on a CAT 5/6 cable tied in through the manufacturer provided CAT 5 Patch Panels.
1. These Analog Secondary Clocks are synchronous 3-wire units with a second hand to mark the fractions of a minute as well as the minute and hour hands. These clocks can be powered from either a

24 VAC or 24 VDC source.

 Provide 12" diameter display, unless larger size is indicated on plans. Clocks shall be housed in a low-profile, semiflush case designed for wall mounting at all locations indicated on the drawings.
 Utilize low profile design to eliminate the need for custom backboxes. Analog clocks designed to be installed on custom oversized back boxes shall not be acceptable. Analog clocks shall be mounted on a standard single gang electrical box.

The system shall provide a master clock system, which shall provide class change signaling and shall serve as a controller to ensure that a consistent time base in maintained throughout the school. The master clock system shall provide the following minimum capabilities:

- 1. The system shall provide the capacity for storing a minimum of 512 events.
- 2. The system shall provide a minimum eight (8) schedules to allow flexibility due to seasonal changes or special events. One or more of the schedules may be active at any given time.
- 3. Classroom speakers may be assigned to any one or more of up to eight (8) time zones. The Master Clock System shall provide the ability to distribute class change signals to any or all of the zones. Time Zones shall be separate from paging zones. The system shall provide separate bell duration for each zone circuit.
- 4. The system shall provide up to sixteen (16) programmable holidays with fully automatic holiday program execution. Bells can be silenced or special schedules can be implemented. Normal bells will resume after the holiday period.
- 5. The system shall provide User-programmable Automatic Daylight Savings Time Change. Two (2) daylight savings time changes may be programmed into the system. The beginning and end dates for Daylight Savings Time shall be programmable.
- 6. The system shall provide the ability to review, edit, and delete events. Editing may take place via a separate computer or via a digital display.
- 7. It shall be possible, using the system's display telephones, to review and change the active schedule of the master clock. It shall also be possible to review and change programmed time events and zones.
- 8. The system shall provide latched operation of zones to control lighting or other devices.
- 9. The system shall provide the ability to test all output zone circuits.

- 10. The system shall interface with all types of secondary slave clocks whether synchronous wired, electronic, or minute-impulse types. This shall be accomplished without the use of external synchronous adapters.
- 11. Accumulation of down time during power outage to reset slave clocks, both minute-impulse and synchronous types after the power has been restored.
- 12. The system shall provide eight (8) output relays for each of the eight (8) zone circuits. Each relay shall be rated at 5 amperes minimum.
- 13. The system shall provide a crystal-controlled time base or national time base interface for assured accuracy.
- 14. The system's time base shall include a Lithium battery that shall provide not less than 5 years battery back-up of the time keeping function.

# 2.11 SPARE CAPACITY/SYSTEM EXPANSION:

A. The Contractor shall include extra (spare) circuits for loudspeakers built into the system for future expansion. Contractor shall provide and install (15%) extra (spare) circuitry (line cards, expanders, hardware interconnect cables, field cabling termination blocks, basic programming, etc.) for these devices. The Owner shall add only field instruments (loudspeakers), field cabling, and final extension programming to make these extra capacity circuits fully operational. The submittal shall contain specific information as to the number of circuits the Contractor will provide & install as to activate all the devices shown on the drawings and in these specifications. The Contractor will also provide evidence in the submission of their spare circuitry/hardware calculations and the supplied & installed hardware to meet this extra (spare) circuitry requirement.

# 2.12 REMOTE SOUND SYSTEMS INTERLOCK:

A. Provide circuits as required to include into the telecommunication system the loudspeakers connected to remote sound systems (i.e. Gymnasiums, Cafeteria, Auditorium, etc.). Remote loudspeakers shall be temporarily Aseized@ for use during paging, two-way intercom, any transmitted tone-sets and program distribution that include the remote system(s) area or zone. After completion of the transmission the remote sound system loudspeakers shall be returned to normal operation. The interlock shall be independent of the functioning of the remote sound system's electronics. The remote sound system shall not be dependent on the remote sound system's electronics or the remote system's AC power status to be fully operational.

# 2.13 LOUDSPEAKERS, BAFFLES, AND BACKBOXES:

A. Provide ceiling loudspeaker assemblies at locations indicated on the drawings. Ceiling loudspeakers shall be 8" diameter with a minimum 5 oz. magnet and industry standard 25-volt multi-tap transformer. Assembly to include an epoxy or powder-paint coated round white steel baffle, a steel back-box with an approved lining and a support cable fastening point, conduit and connectors as required and a steel AH@ or AT@ type grid support mechanism. In no case shall the ceiling grid solely support the loudspeakers. Speaker/Baffles: Provide backboxes to electrical subcontractor for installation.

- 1. provide a ceiling mounted round speaker and baffle assembly. The baffle shall be 12-7/8" in diameter and 3/8" deep. The circular design shall match the room ceiling tiles.
- 2. Baffle shall be constructed of 22 gauge, cold rolled steel, coated with a baked on white powered epoxy that is resistant to scratches.

- 3. Holes in the baffle shall allowing mounting to speaker backbox.
- 4. Room speakers must allow hands free talk back when room is paged.
- 5. Speakers must meet the following:
  - a. Type: Flush mounted 8" cone
  - b. Frequency Response: 50 to 18,000 Cycles
  - c. Magnet: 6 oz.
  - d. Axial Sensitivity 95 dB at 4 ft. with 1-watt input
  - e. Speaker/Transformer/Baffle Assembly with Support Bridge and Enclosure as required or equal.
  - f. 1 X 2 or 2 X 2 Lay- in style speakers matching the above transformer and speaker characteristics shall also be acceptable

B. Provide wall-mounted weatherproof exterior loudspeaker assemblies at locations indicated on the drawings. Manufacturer and type of loudspeaker may vary depending on architectural considerations. Loudspeaker shall contain a high compression horn, 25-volt multi-tap transformer, and be water, dust, wind, vandal and insect resistant in design. Loudspeaker shall be capable of flush, mounting <u>Surface mounted or semi-flush mounted exterior loudspeakers are NOT acceptable</u>. Loudspeaker shall be constructed of epoxy painted die-cast aluminum or die-cast zinc. Stamped steel and/or plastic loudspeaker assemblies are not acceptable.

C. Provide exterior call-station and loudspeaker assemblies at locations indicated on drawing. Assembly shall contain a waterproof 25-volt loudspeaker with multi-tap transformer, an integral call-in switch and be vandal resistant in design. Assembly shall be constructed of 11 gauge stainless steel and be capable of flush or surface mounting as required. An internal baffle shall be part of the assembly to prevent loudspeaker damage from intrusion by inserted pointed objects.

D. Provide indoor horn type loudspeaker assemblies at locations indicated on the drawings. Loudspeaker shall contain a high efficiency 30 watt horn, 25 volt multi-tap transformer, and be water, dust, wind and insect resistant in design. Loudspeaker shall be capable of surface mounting as required. Loudspeaker shall be constructed of painted aluminum, steel, or reinforced fiberglass. Horn Speakers: Indoor/Outdoor (External Building PA Speakers (recessed), Internal PA Speakers for the Gymnasiums (recessed with protective enclosures)

- 1. Double re-entrant type: flush mount installation.
- 2. Frequency Response: 600 to 14,000 Hz.
- 3. Power Handling: 15 Watts RMS, 30 Watts Peak.
- 4. Variable screw taps, 25 V transformer
- 5. Sound Pressure Level: 110 dB at 1 meter with 1-watt input
- 6. Color: Coordinate with Architect.
- 7. Atlas/Soundolier APF-15T Horn Speaker with 193-8-6 backbox (9-5/8" Sq X 6" Deep) and VP-161APF Speaker Baffle or equal.

E. Volume Controls: Provide Volume attenuators where shown on the drawings to adjust the volume of the local PA speaker.

## 2.14 MISCELLANEOUS:

A. Connectors: Loudspeaker cabling shall be terminated neatly and logically on split 50 pair Type 66 mass termination blocks. All connectors shall be as recommended by the manufacturer or as indicated on the drawings. Provide a service access point in the form of bridging clips for all stations, loudspeakers, and

systems= interface connections. Provide hinged covers on all 66 type connector blocks and label covers for circuits contained within. All blocks and cabling connections and terminations shall be installed on fire-treated plywood backboard(s), minimum of 3/4" thick, and painted as specified.

B. Amplifiers: System audio amplifiers selected by the Contractor shall be loaded no more than 80% of rated capacity. Amplifiers shall be rated for continuous commercial duty operation and as recommended by the Manufacturer of the telecommunication system. System shall deliver a minimum of 93 dB at 1 meter at each and every indoor loudspeaker in the system.

C. Equipment Rack: Equipment rack(s) shall be provided for the telecommunication system. The rack shall be upright, floor standing, steel, with a locking rear door and ventilated as required to meet the environmental requirements of the equipment manufacturers. Finish shall be textured black. All unused rack space shall be blanked off with matching steel panels. All central switching equipment, amplifiers, program sources, etc. shall be mounted in the rack(s).

D. Cabling: Plenum cabling for two-way microphone/loudspeaker circuits shall be two (2) conductors 20 - 22 AWG shielded, with gray or white colored overall jacket. Refer to Gymnasium and Cafeteria Sound Systems for their loudspeaker cable requirements.

# 2.15 UNINTERRUPTIBLE POWER SUPPLY/SURGE SUPPRESSION (UPS):

- A. The contractor shall make space provisions at the bottom of each rack for an FCPS furnished UPS and external battery. Contractor shall install FCPS furnished UPS & battery unit.
- B. Contractor shall be responsible for coordinating the electrical receptacle mounting on the data rack.

## PART 3 - EXECUTION

## 3.1 GENERAL:

The conditions of the General Contract (General, Supplementary, and other Conditions) and the General Requirements are hereby made a part of this Section.

Install and connect all appliances and equipment as specified and shown on the contract drawings in accordance with the manufacturer=s instructions and recommendations. Furnish and install complete electrical service and electrical connections as recommended by the manufacturer and as required for proper operation. Prior to roughing in outlets, verify locations, voltages, phase, current rating and type of outlet required from approved shop drawings.

A. Mark switches, connectors, jacks, receptacles, conduits, outlets, cables, and cable terminations, clearly, logically, and permanently.

B. Program system per instructions of the Owner.

C. Execute, without claim for payment, moderate moves or changes necessary to accommodate other equipment to assure symmetry and pleasing appearance.

D. The system must be matched. All major electronic equipment must be assembled, tested and furnished by one equipment supplier.

E. Final appearance and finishes are subject to the Owner=s approval.

F. System amplifiers shall be loaded no more than 80% of rated capacity. System shall deliver a minimum of 93db at 1 meter at each and every loudspeaker in the system.

G. Cabling types shall be installed per manufacturer=s recommendations in plenum, non-plenum or conduit as required or as indicated on the drawings.

H. Cabling shall be marked and terminated neatly and logically as specified.

I. Articulation shall be a minimum of 85% (ALCONS) in all interior areas.

3.2 INSTALLATION:

A. Install equipment to comply with manufacturer's written instructions.

B. Wiring Method: Install wiring in raceway except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum-board partitions where cable-wiring method may be used. Use plenum cable in environmental air spaces, including plenum ceilings. Conceal cable and raceway except in unfinished spaces.

C. Install exposed cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings so designed and installed to avoid damage to cables. Secure cable at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, or fittings.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.

E. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.

F. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) for speakers and microphones and adjacent parallel power and telephone wiring. Separate other school intercom and program equipment conductors as recommended by equipment manufacturer. Maintain a minimum separation of 48" between IPC cabling and electrical transformers.

G. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

H. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

I. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables to identify media in coordination with system wiring diagrams.

J. Cut and patch existing walls, ceilings, floors, or other building finishes for installation. Repair, restore, and refinish surfaces to original appearance.

## 3.3 GROUNDING:

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Ground and bond the IPC racks in accordance with the requirements in Section 16770; Voice/Data/Video Systems.

3.4 FIELD QUALITY CONTROL:

A. Programming: Fully brief Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

B. Operational Test: Test originating station-to-station, all-call, and page messages at each intercom station. Verify proper routing and volume levels and freedom from noise, rattles, hum and distortion. Test each available message path from each station on system.

C. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.

D. Signal-to-Noise Ratio Test: Measure the ratio of signal to noise of complete system at normal gain settings, using the following procedure:

- 1. Disconnect a speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure the ratio of signal to noise at paging speakers.
- 2. Repeat test for three speaker microphones, one master station microphone, and for each separately controlled zone of paging loudspeakers.
- 3. Minimum acceptable ratio is 45 dB.

E. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each intercom, paging, and all-call amplifier. For each frequency, measure the distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is five (5) percent total harmonics.

F. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 2500 Hz. Use a sound-level meter with octave-band filters to measure level at five locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB, and in levels between adjacent zones is plus or minus 5 dB.

G. Power Output Test: Measure electrical power output of each paging amplifier at a normal gains setting at 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.

H. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Division 16 Section "Grounding."

I. Retesting: Correct deficiencies and retest. Prepare written record of tests.

J. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging and independent room speaker-line matching transformers.

K. Schedule tests with at least seven days advance notice of test performance.

## 3.5 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment as specified below:

- 1. Train Owners' maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining equipment. The contractor shall provide at no additional cost, a minimum of four (4) hours of training. This training is in addition to and separate from the training specified elsewhere for administrative/staff operations.
- 2. Review data in maintenance manuals.
- 3. Schedule training with Owner, through Engineer, with at least seven days' advance notice.

B. The Instructor shall be familiar with all parts of the system on which instruction is to be given, and shall be trained in operating theory as well as in practical operation and maintenance work.

C. Conduct walking tour of project and describe function, operation, and maintenance of components. Provide volume adjustments as necessary to provide acceptable sound levels to the Owner.

## 3.6 DOCUMENTATION:

A. The conditions of the General Contract (General, Supplementary, and other Conditions) and the General Requirements are hereby made a part of this Section.

B. A comprehensive installation, operation, programming and instruction manual shall be supplied as part of the system. The manual shall provide complete service information, including schematics, layout drawings, interconnecting diagrams for this particular project and parts lists to permit quick and efficient maintenance and repair of the equipment by a qualified technician. Refer to the General Contract Provisions for configuration, required information and quantity of the Operation and Maintenance Manuals to be provided.

C. A simplified operation guide, suitable for use by the school staff, shall also be provided. This guide shall provide step-by-step instructions for all available functions and an orderly directory for all system extensions. Provide one manual for each administrative office for applicable administrative and ICS functions.

D. As-built drawings: 3 sets. They should include up-to-date drawings that include any changes made to the system during installation. Circuit diagrams and other information necessary for the proper operation and maintenance of the system shall be included. Drawings must be provided on CD in AutoCAD format.

## 3.7 OCCUPANCY ADJUSTMENTS:

A. On-site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions at no additional cost.

B. Adjust controls to achieve proper operations.

C. Set status of each classroom call-in device and other stations as indicated.

D. The specified standard of equipment shall be supplied, installed, adjusted, tested, and guaranteed by a factory-authorized contractor for the products furnished. The contractor shall be responsible for verifying the completeness of the parts list and the suitability of the equipment to meet the intended purpose of the specifications and to serve the best interests of the owner.

## 3.8 LOOSE EQUIPMENT:

A. Deliver to the Owner at the end of the project, all loose equipment including microphones, stands, etc. Obtain signed delivery receipt and include copy of receipt in Operation and Maintenance Manuals for the system.

## END OF SECTION

# SECTION 27 70 00 - EMERGENCY RADIO IN-BUILDING AMPLIFICATION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. SCOPE:

Provide In-Building Radio Amplification System in compliance with Frederick County regulations requiring in-building radio signal amplification systems this building. The regulation was in form of an amendment to the 2003 International Building Code and is as follows:

**B.** General. Every floor area in this building shall be provided with Radio amplification in order to achieve the required level of radio coverage as established by Frederick County.

**C. Inspection and Testing.** Radio coverage and in-building signal amplification systems shall be tested, and inspected by approved and qualified individuals. The results of the testing and inspection shall be certified to the code official prior to issuance of an occupancy permit.

# D. REQUIRED LEVEL OF SIGNAL COVERAGE AS ESTABLISHED BY FREDERICK COUNTY

- Signal measurement is required to be -95dbm or stronger at a given point;
- Entire building is 95% or above covered (including all underground levels, basement, elevators, stairways, etc) at 95% of the time;
- An in-building signal amplification system is required to provide coverage at Delivered Audio Quality (DAQ) 3.4 level or above. DAQ 3.4 is defined as speech understandable without repetition. Some noise/distortion present.

## E. Responsibility

## 1. In-Building Coverage System

To amplify the signals inside a building or structure not meeting the above standard, an FCC type-accepted Bi- Directional Amplifier (BDA) with any of the following shall be installed in order to achieve the required radio coverage: a radiating cable system, a distributed antenna system, or a combination thereof. shall be used as needed.

## 2. Design

It is the Contractor's responsibility to obtain the services of a professional wireless contracotr to evaluate and test the required level of signal coverage in the building and to design and install the in-building signal amplification system. The in-building coverage design shall consider, but is not limited to, the following criteria: FCC limits on BDA output power, power per carrier, signal-to-noise ratio, RF filtering, adjacent band interference, inter-modulation interference and distortion, uplink noise output, antenna locations, and proper cable size.

## 3. New Building Construction - System Installation

The Contractor shall provide complete information and survey and signal strength maps to be used as part of an RPF to procure the services of the proposed system installation under a separate contract.

## PART 2 - PRODUCTS

- 2.1 DELIVERABLES
- A. SHOP DRAWINGS: The Contractor shall submit a comprehensive and complete signal strength coverage shop drawing. The shop drawing shall be scale 1/16" or larger and shall be in both hardcopy and in electronic format (PDF).
- B. REPORT: The contractor shall include a signal strength survey report including recommendations for the type of system and equipment to be required to provide the required level of signal coverage as established by Frederick County.

PART 3 - EXECUTION NOT USED

# **END OF SECTION**

# SECTION 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Electronic safety and security equipment coordination and installation.
  - 2. Sleeves for raceways and cables.
  - 3. Sleeve seals.
  - 4. Grout.
  - 5. Common electronic safety and security installation requirements.

## 1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

## 1.4 SUBMITTALS

A. Product Data: For sleeve seals.

#### 1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  - 3. To allow right of way for piping and conduit installed at required slope.
  - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

- C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."."

## PART 2 - PRODUCTS

## 2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
    - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

## 2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
  - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
  - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
#### 2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

# PART 3 - EXECUTION

# 3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

# 3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

- A. Electronic safety and security penetrations occur when raceways, 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 inches (50 mm** above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway 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 raceway 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 raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways 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-inch (25-mm) 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-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

## 3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use 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.

#### 3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

#### **END OF SECTION**

### SECTION 281605 - INTEGRATED CCTV SURVEILLANCE SYSTEM

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes provisions for an Owner furnished a new CCTV system for security surveillance. Contractor provisions include providing data rack, UPS and all cabling and connectors required to complete the system. Owner (FCPS) will provide cameras, digital video recorder software, power supplies, mounting hardware, monitors.
- B. Contractors shall be responsible for pulling cabling from the designated Security Head End Equipment Rack located in the MDF to each individual camera location. The Contractor shall be responsible to mount and wire the cameras at each individual location. Contractor shall install all FCPS furnished flush mount kits.
- C. FCPS will be responsible for installing the Security Head End equipment and final focus of all cameras.
- D. FCPS will furnish all cameras and camera brackets for the contractor to install.

## 1.2 RELATED SECTIONS

- A. Requirements applicable to electrical work specified in Division 26 apply to work of this section.
- 1.3 SYSTEM DESCRIPTION
  - A. This Section includes a CCTV system for security surveillance, including cameras, video server, power supplies, mounting hardware, monitors, UPS, LAN switch, data rack, and all cabling and connectors required to complete the system. The video can be viewed and archived locally as well as remotely via the LAN.

#### 1.4 SUBMITTALS

- A. General: Comply with Division 1 and Section 26.
- B. Product data:
  - 1. Include data on features, components, ratings, and performance.
- C. Shop drawings:
  - 1. Include dimensioned plan and elevation views of components and enclosures and details of control panels. Show access and working space requirements.
  - 2. Wiring diagrams detailing internal and interconnecting wiring for power, signal, and control and distinguishing between field-installed, owner-installed wiring and factory-installed wiring.
  - 3. Coordination drawings: Plans drawn to scale, showing the locations of the CCTV equipment rack. Include proposed camera rough-in locations and mounting details.
- C. Certificates: Signed by manufacturer, certifying products comply with specified requirements.

- D. Qualification data for manufacturer and installer as specified in "Quality Assurance" below.
  - 1. Include evidence of installer's RCDD from BiCSi.
- E. Field test reports for tests specified in Part 3.

# 1.5 QUALITY ASSURANCE

- A. Manufacturer qualifications:
  - 1. Firms experienced in manufacturing systems and equipment of the same types and capacities used for this project that have a record of successful in-service performance. The equipment for this project must be as manufactured by Interlogix.
- B. Installer qualifications: Factory-authorized service representative of the television system manufacturer.
  - 1. Installer shall have on its regular full-time staff a registered communications distribution designer (RCDD) with LAN specialization, who shall approve and supervise cabling work and network integration.
  - 2. Installer shall obtain the equipment and materials from a fully factory authorized dealer, with a signed agreement from the manufacturer.
  - 3. Installers must be factory-trained and certified on the Interlogix system. Provide proof of the certification and provide at least five completed installations using the Interlogix equipment. Provide building name and contact person information. Owner reserves the right to inspect the systems used as references. Companies not certified at time of bid will not be considered.
- D. Comply with NFPA 70, National Electrical Code.
- E. Comply with FCC Part 15, Rules and Regulations, Radio Frequency Devices.
- F. NRTL Listing: Provide listed and labeled system components for which there are listings and labeling services.
  - 1. The Terms "listed" and "labeled": As defined in the National Electrical Code, Article 100.
  - 2. Listing and labeling agency qualifications: A Nationally recognized testing laboratory (NRTL) as defined in 29 CFR 1910.7.

## 1.6 PROJECT CONDITIONS

- A. Environmental limitations: System components shall be equipped and rated for the environments where installed.
  - 1. Service conditions for outdoor equipment: Rate equipment for continuous operation under the following environmental conditions, unless otherwise indicated:
    - a. Temperature: Minus 22 deg F (30 deg C) to plus 122 deg F (50 deg C).
    - b. Relative humidity: 5 to 100 percent.
    - c. Weather: Enclosure housings shall prevent entry of moisture including ice and driven rain or snow.

- 2. Service conditions for indoor equipment: Rate equipment for continuous operation under the following environmental conditions, unless otherwise indicated:
  - a. Temperature: 32 deg F (0 deg C) to 122 deg F (50 deg C).
  - b. Relative humidity: 0 to 95 percent.

## 1.7 COORDINATION

A. Coordinate layout and installation of CCTV equipment and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

#### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

A. GE Security SymSecure products will be used for the project. No other manufacturers shall be acceptable.

#### 2.2 CAMERAS AND POWER SUPPLIES

- A. Exterior Cameras shall be provided by FCPS and will be Interlogix indoor/outdoor fixed rugged dome analog cameras
- B. Central power supply: FCPS will provide Altronix rack mounted power supply. 24Vac output providing eight isolated, one-amp outputs. Each output shall be independently fused.

#### 2.3 SIGNAL TRANSMISSION COMPONENTS

- A. Cable: RG-59 Coaxial plenum rated type from the DVR to each camera location.
- B. Low Voltage Power : provide 2 conductor #18 plenum rated cable to each camera.

## 2.4 MONITORS

A. FCPS will furnish and install all video display monitors.

B. Contractor shall coordinate exact location for all monitor outlets and power and video cabling requirements.

#### 2.5 DIGITAL VIDEO SERVER

A. FCPS will furnish and install the required Digital Video Recorder(s) (DVR). FCPS will provide the Interlogix TruVision DVR rack mounted in the contractor furnished security equipment rack.

## 2.6 EQUIPMENT RACKS

A. 72" Wall-mounted modular metal racks arranged to house standard mounting electronic equipment, 21 inches wide, steel shelf enclosure with 16-gauge ends and 18-gauge shelves, six pieces bolted together, with four mounting holes on 16-inch centers for mounting to wall studs. Weight capacity 150 pounds. Finish: Standard black powder coat.

# 2.7 UPS

A. FCPS will furnish a mounted UPS. Contractor shall install UPS in rack.

# PART 3 – EXECUTION

# 3.1 PREPARATION

A. Camera location test: Support each camera temporarily at the location indicated and connect to monitor. Adjust location and mounting and substitute fixed lenses, if required to obtain clear image at monitor. These adjustments shall be included in the contract sum.

# 3.2 INSTALLATION

- A. Comply with requirements of Sections 16050, 16120, and 16131.
- B. Outdoor installation: Conform to ANSI C2, National Electrical Safety Code.
- C. Install wiring in raceways except as otherwise indicated.
- D. Wiring in enclosures: Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars and distribution spools.
- E. Pulling Cable: Do not exceed manufacturers recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between indicated termination, tap, or junction points. Remove and discard cable where damaged during installation and replace it with new cable.
- F. Equalization of video signals: Where system performance may be degraded in certain operating modes because of varying connections of multiple devices from mode to mode, revise component connections and install video distribution amplifiers and attenuators as required to provide consistent acceptable performance.
- G. Splices, taps, and terminations: For power and control wiring use numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets, and equipment enclosures. Tighten connection to comply with tightening torques specified in UL 486A.
- H. Grounding: As recommended by manufacturers except as otherwise indicated.
- I. Installer's RCDD shall supervise each final connection to equipment.
- J. Install cameras in the locations indicated, adjusted to final locations defined by camera location tests. Provide adequate headroom below cameras and their mountings. Where necessary, change the type of mounting to provide adequate headroom.
- K. Pan units and pan and tilt units: Set stops to suit final position and mounting and field required to be viewed by the camera.
- L. Install central power supply, server, UPS, monitor and other auxiliary components in equipment rack.

# 3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals.

# 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's field services: Provide services of factory-authorized service representatives to supervise the field assembly and connection of components and system pretesting, testing, and adjustment. Installer's RCDD personnel shall supervise cabling and network integration.
- B. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
- C. Pretesting: Align and adjust the system and pretest all components, wiring, and functions to verify they conform to specified requirements. Replace malfunctioning or damaged items with new items. Retest until satisfactory performance and conditions are achieved.
- D. Final acceptance testing schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 2 weeks. Provide a minimum of 10 days notice of acceptance test performance schedule.
- E. Operational acceptance tests: Perform operational system tests to verify conformance to specifications. Include all modes of system operation. Methodically test for proper system operation in each functional mode.
- F. Record results of tests.
- G. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

## 3.5 CLEANING

A. Clean system components including camera housing windows, lenses, and monitor screens. Use methods and materials recommended by manufacturer.

## **END OF SECTION**

# SECTION 28 23 01 - INTEGRATED INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

# 1.1 GENERAL:

A. The conditions of the General Contract (General, Supplementary, and other conditions) and the General Requirements are hereby made a part of this Section.

B. All bids shall be based on the performance of the system as specified herein. All systems must be approved by the specifying authority.

# 1.2 SCOPE OF WORK:

A. Furnish and install all equipment, accessories, and materials in accordance with these Specifications and drawings to provide a complete and operating integrated Security System consisting of security control panel, command center, power supplies, alarm sirens, contacts, sensors, point of protection devices, wiring and other products as required for a complete system.

B. Provide a complete and ready intrusion detection security system. The system shall safeguard the perimeter and interior of the building against theft and vandalism. Equipment used shall be UL listed and the product of a manufacturer with established reputation and experience, who shall have produced similar equipment for a period of at least ten years.

C. All equipment such as control units, sensors, key pads, etc., shall be furnished in the quantities called for, and located where indicated on the plans and drawings. The Intrusion Detection System, as herein specified and as located on the Drawings, had been designed around the control panel, as manufactured by Honeywell Ademco. Alternate equipment of other manufacturers may not be substituted on a piece-for-piece basis as the motion detection coverage will be less.

D. Should alternate equipment be proposed for use on this project, a complete set of Specifications, drawings, and catalog cuts describing the proposed equipment along with a drawing showing the quantity and location of all equipment must be submitted to the Architect for consideration at least ten working days before the bid date. It will be the responsibility of the parties proposing the alternate equipment to provide that the system and equipment they are proposing is equal to or better than the system and equipment as specified.

## 1.3 QUALITY ASSURANCE:

A. The alarm installer shall have been regularly engaged in the alarm business for the past five years, shall be a manufacturer authorized dealer, and shall provide proof of installing at least three systems of equal size in the past two years, to the Owner; no exceptions. No subcontracting of wire installation shall be allowed to any Electrician by the Contractor.

B. All equipment components of the security alarm system shall be the standard manufactured product of a company engaged in the manufacture of security alarm systems for at least five (5) years.

C. Unless otherwise indicated, the system and its components specified, and their installation and operation shall conform to the latest applicable requirements of the following:

1. National Fire Protection Association (NFPA):

NFPA 70 National Electrical Code

2. Underwriters Laboratories (UL):

Electrical Construction Materials Directory

- 3. Factory Mutual Approval Guide
- 4. Building Officials and Code Administration (BOCA) National Building Code
- 5. Americans with Disabilities Act (ADA)
- 6. Maryland Occupational Safety and Health Act

D. All system components must be UL Listed individually and for use as a complete system where required by State and/or Local Codes. Devices and or systems must be approved for use in the planned locale, where such approval is required by the Authority having jurisdiction.

E. Acceptable evidence of compliance of components is a UL or FM label or listing or an independent Certification, satisfactory to the Engineer, that the components meet the applicable standards.

F. Comply with UL Household Burglary and Fire Standard.

G. Comply with NFPA 74, NFPA 72, NFPA 71, and Factory Mutual.

H. All work shall adhere to standard engineering practices, and shall comply with appropriate national, state, and local building codes.

# 1.4 MANUFACTURERS:

A. The following control equipment shall be used in this project as it is the same as used in other County Schools and conforms to other system designs for ease of service and maintenance ability. No substitutions shall be allowed. All field devices shall be as listed for the same reasons.

1.5 SYSTEM FUNCTION AND OPERATION:

A. Alarm Reporting: All signals shall report to the authorized central station service provider under Contract to the Owner. This programming shall be coordinated with the Owner provider.

B. Zoning: There shall be no less than seventy (70) zones using point of protection devices and on-board points. All zones shall be customized on the Command Center.

- 1. Each motion detector shall be addressed as a single zone.
- 2. Groups of four (4) glass break sensors (maximum) shall be on a single zone.
- C. The system shall provide perimeter and internal protection by the use of motion sensors.

D. The system shall be installed so that additional area protection may be added, whenever required, without obsolescence to existing equipment.

E. The system shall have the capability to be able to arm or disarm system from any On/Off premise touch-tone telephone.

F. A magnetic door contact shall be provided at each door with a keypad. The door contact at the main entry shall sound a pre-alarm signal on time delay to allow for disarming the system.

G. Each door and motion detector shall be on a separate point (zone). Each device shall have its own built-in or dedicated RPM for point identification by zone (remote-point-module). Looping multiple devices onto a single zone is not acceptable. The control panel shall be capable of monitoring a minimum of 70 separate points.

H. The system shall detect unauthorized entry at various locations using a combination of magnetic door contacts and interior motion detectors. All circuit runs shall be supervised by addressable devices or end of line resistors. All devices shall be UL approved.

I. Each detections device shall report to the arming station as a separate independent zone. All zones shall report in alpha/numeric English language for ease of identification of trouble and zone alarms. Main controls shall be housed in a common enclosure.

J. The control/communicator shall be a single UL-approved microprocessor unit with the ability to monitor and report up to 8 individual partitions, up to 64 zones, with multiple devices per zone.

K. Remote arming stations shall include a touchpad station with LCD status message display in a common enclosure. Remote arming station/annunciator panels shall display all alarms, trouble messages, etc., in alpha/numeric English language. Arming station/annunciator shall be UL approved.

L. Upon detection of unauthorized entry, the system shall report alarm information at the main control panel, display alarm information at the remote annunciator panels, and send all digital reports to the Owner's central station alarm monitoring company.

M. Security alarm system shall be partitioned (zoned) to allow after-hours use of defined areas while the remainder of the building is armed. Partitioning shall allow use of zones individually or simultaneously. Partitions shall be as defined below. Coordinate zones with the Owner and actual device mounting locations prior to programming.

- 1. Gymnasium/Parks & Recreation Zone shall bypass selected areas within the building system to permit entry and after hours use of the gymnasium, cafetorium, stage, kitchen and associated areas. Coordinate exact boundaries of after-hours use with Owner prior to installation and programming.
- 2. Provide subcontrol keypads to allow use of designated areas for recreational purposes and allow full security of remaining school areas. A special subzone code will be sent whenever the subzone is disarmed or armed by any authorized user or group of users. An entry/exit delay loop and instant loop will be a part of this subzone control.

# 1.6 SUBMITTALS

A. Submit shop drawings, product data, itemized equipment list, wiring diagrams, and manufacturer's literature and 1/16 scale plan indicating components and cabling requirements.

B. Indicate system components, size of components, location and provide full schematic or wiring system showing building and operation details.

- C. Submit manufacturer's installation instructions.
- D. Submit manufacturer's descriptive literature, operating instructions, and maintenance and repair data.
- E. Equipment submittals shall include the following:
  - 1. Manufacturer's literature and illustrations.
  - 2. A description of the system operation which includes the method of operation and supervision of each type of circuit operation of manual controls, and sequence of operation.
  - 3. Wiring diagrams which show the method of wiring for each type of circuit for each function performed. These shall include the following:
    - a. Each type of alarm initiation circuit.
    - b. Each type of alarm signaling circuit.
    - c. Annunciation methods.
    - d. Control methods (separate diagrams shall be provided for each type of device controlled).
  - 4. Each wiring diagram shall indicate:
    - a. Method of fusing and location of fuses on the circuit.
    - b. Recommended wiring type and size and methods of ground or shielding (if used).
    - c. Terminal identification at control panels and remote devices.

F. Submission of shop drawings without the 1/16" scale floor plan, wiring, and connection diagrams shall be cause for rejection of the submission.

## 1.7 COORDINATION

A. Coordinate protection zones with the Owner, after-hours use areas, or other structural elements, and Specifications for proper function. Specifically, coordinate the deactivation of any subzones from remote entry points while remainder of building is protected.

B. All related work specified in other sections shall be properly coordinated with the security alarm equipment.

C. Prior to the installation, the alarm system contractor must meet with the Owner to confirm the installation procedures, zoning device locations, and to resolve any concerns regarding equipment installations.

D. The alarm system contractor shall coordinate the installation of all equipment and systems to prevent interference from other building equipment or systems.

E. Alternate device locations must be approved by the Owner's representative and the Project Engineer.

F. The alarm system installation contractor is required to constantly, or as otherwise directed by the Owner, maintain a fully operating system in all or any part of a building which is occupied or which houses equipment and/or supplies.

G. Coordinate with the Owner for the Central Station Service Account Number for digital communicator and specific programming directions.

# PART 2 - PRODUCTS

# 2.1 WIRING

A. System wiring and equipment installation shall be in accordance with good engineering practices as established by the EIA and the NEC. Wiring shall meet all State and local electrical codes. All wiring shall test free from all grounds and shorts.

B. Detection system shall be wired in accordance with manufacturer's instructions and shall meet applicable provisions of national and local codes. All system field wiring shall be supervised; unsupervised point wires shall not be permitted. Final connections between field wiring system and control and annunciator equipment shall be made under the direct supervision of a fully qualified technical representative of the equipment manufacturer.

C. Connections shall be made with 4 conductors of #18 gauge twist/shielded wire, type THHN, colorcoded and kept entirely independent of all other wiring. Exposed wiring in public areas will not be accepted. All wiring shall be plenum-rated. All wiring shall be installed in conduit.

D. Wiring quantities, if shown on plans, are for general information only. Actual wiring quantities point-to-point shall be per detection system manufacturers' wiring diagrams.

E. Wiring to keypads shall be a dedicated loop of four #18 AWG shielded cable. All wiring shall be installed in conduit.

F. Wiring to power the devices shall be a dedicated loop of two #18 AWG cable. All wiring shall be plenum-rated.

G. Wiring to serve data circuits for devices shall be a dedicated loop of two #18 AWG shielded cable. All wiring shall be plenum-rated.

H. Wiring to all devices shall be as recommended by the Manufacturer.

I. Furnish and install all wiring, equipment, and associated appurtenances in accordance with all Drawings, Specifications, and the manufacturer's installation instructions.

J. All wiring is to be marked with numbered wire markers at each end throughout the project. The wire marking information will be turned over to the Owner.

- K. Complete raceway system of conduits and outlets shall be provided, including the following:
  - 1. Between interface junction cabinet and area junction boxes.
  - 2. For plenum wiring when cables are not approved for plenum use.
  - 3. To span above plastered ceiling or any other area that has limited access to cables.
  - 4. From each motion detector to area above drop ceiling.
  - 5. For twelve (12) conductor 22 gauge, jacketed stranded, copper, wire installed between interface junction cabinet in Boiler Room for future monitoring of energy management sensors.
  - 6. For cable between Fire Alarm control and main security interface junction used to monitor Fire Alarm.
- L. Interface Junction Cabinet:
  - 1. The Contractor shall furnish and install a finished, smooth-edged junction cabinet with a side hinge lockable cover 18" x 24" x 6".
  - 2. The junction cabinet shall be mounted on a 4' x 4' x 3/4" piece of plywood. Only equipment related to the security system is to be mounted on this plywood. Cabinet shall be located in the area with telephone incoming service.
  - 3. Provide two parallel 1" conduits between the junction cabinet and security control box.
  - 4. Provide and install barrier terminal strips in junction cabinet to accommodate each individual motion conductor's power and circuit.
  - 5. Provide and install numbered wire markers to identify each cable.
  - 6. Barrier type terminal strips shall have double screws 6-32 x 1/4 binder head nickel-plated brass screws.

## 2.2 CONTROL

A. Honeywell **Ademco VISTA 250-BP** Control/Communicator: Provide module for 250 points of protection, eight programmable areas, 500 event log, auto reset, 12 VDC 2 amp. Power with battery, 7-Hour standby, and all required accessories.

1. Batteries: Rechargeable, valve-regulated, recombinant, sealed lead-acid type with nominal 10-year life expectancy. Capacity adequate to operate portion of system served, including

audible trouble signal devices for up to seven (7) hours and audible and visual alarm devices under alarm conditions for an additional ten 1(10) minutes.

- 2. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger recharges fully discharged battery within 24 hours.
- B. Provide heavy-duty cabinet with lockable cover.

## 2.3 REMOTE COMMAND CENTER KEYPAD

A. Ademco 6160 Alpha Command Center to be used with the Vista 250. Provide locking protective cover with twelve (12) spare keys by Safety Technology, Inc. (STI) Model 6560. See Drawing.

# 2.4 INDEPENDENT COMMAND CENTER KEYPAD

A. Ademco 6160 independent zone control for separation of zoned point from main system. See Drawing.

## 2.5 POWER SUPPLIES

- A. System shall utilize sufficient power source for operation of all devices.
- B. Provide signal boosters to ensure sufficient operation of equipment.

# 2.6 ALARM SIRENS

A. Provide alarm sirens, where indicated. Security sirens shall be clearly distinct from the fire alarm and other paging or signaling systems in the building.

B. Interior sirens shall be mounted flush in wall with plastic grill. Minimum sound output shall be 88 dB at 10 feet. Provide Wave 2F Siren, or equal, and compatible with Security System furnished.

C. Provide all required power supplies, siren drivers, etc., for operation.

D. Exterior sirens shall be UL listed for outdoor use. Sirens shall be 120 dB at 10 feet, cone type speaker horn. Sirens shall be Bosch Model D117, or equal. Unit shall contain a built-in siren driver. Provide either a steady or yelp output.

# 2.7 DOOR CONTACTS

A. Door contact switches shall be wide gap, magnetic type, with all contacts hermetically sealed against dirt, moisture, etc. Units shall be recessed in doors and frame unless not possible. Provide armored leads. Where surface mounting is required, obtain approval for mounting and device type prior to work. Contacts shall be supervised for open circuits, wiring shorts, etc. Unit shall not be affected by normal temperature swings, vibration, shock, etc. Provide Sentrol #250SA, Bosch TAP-SD70W or approved equal. Mount contacts on top of door, approximately 3 inches from the opening edge.

B. It shall be the responsibility of the alarm installing contractor to verify that work efforts are coordinated for the installation of door contact hardware and wiring during the very early phase of construction. Coordinate the exact location and size of each opening required in each door buck frame, lintel, etc., for

raceway, backbox, etc. All wiring shall be installed in raceway run concealed in wall to door contact. Exposed wiring will not be allowed.

C. Interior and exterior door contacts: Each shall be individually home run, zone-wired and indicate alarm.

# 2.8 OVERHEAD CONTACT

A. Provide a floor mount magnetic door contact, Sentrol 2202A with a 3-foot armored cable for each overhead exterior door. See Drawings.

## 2.9 GLASS BREAK SENSORS

A. Glass break sensors shall be C&K, Intellisense FG730. Sensors shall be installed to *Latch* and stay *latched* until released by utilizing the keypad function (Command 47), alarm system reset feature, on the keypad. Provide relays as required to facilitate this reset function.

# 2.10 DROP THERMOSTATS

- A. Drop thermostats shall be set at  $50 \square F$ .
- B. Thermostats shall be installed at locations which will give adequate warning when the heating system has failed. Provide suitable flush wall-mounted backbox and conduit run concealed in wall and turned out above accessible hung ceiling for wiring.
- C. Each thermostat must be wired independently from sensor to interface junction box.

## 2.11 LONG RANGE DUAL TECHNOLOGY MOTION SENSORS

A. Motion detectors shall be passive infrared (PIR) devices that use motion analyzer II signal processing to reduce false alarms. Devices shall have a built-in Popit with tamper sensor. Devices shall use mirrored optics with four coverage patterns (35' by 35'; 35' by 10'; 70' by 10'; or pet 35' by 35' with 70' long range. A tamper condition shall be signaled through the Zonex bus and displayed at the keypads when the cover is removed. Detector shall not be adversely affected by air currents, heat, temperature, light, sound, vibration, etc. Provide vandal-resistant mounting brackets for all detectors. Provide Honeywell DT900 series.

B. Provide a recessed device box at height of detector for wall mounting, adjacent to mounting bracket. Box shall have a stainless steel cover with center rubber grommet for wiring penetration. Allow a minimum of 12" of cable coiled inside box following connection to detector.

## 2.12 POINT OF PROTECTION DEVICES

A. Point of protection addressable modules shall be Honeywell 4208SN.

B. Each sensor shall have a corresponding point of protection device attached.

C. Provide a standard double gang electrical box with corresponding zone number displayed on box cover. Covers shall be painted blue. Devices shall be installed in a location near their protected device and also where easily serviced.

#### 2.13 MISCELLANEOUS DEVICES

A. Provide programmable output relays as required for a complete system.

B. Provide one (1) multiplex signal booster to ensure sufficient operation of equipment to be installed and for future additions to multiplex data loop.

C. Provide wire guards or clear Lexan protective covers for all devices located in exterior locations and where subject to damage (i.e., gyms or alternate gyms).

D. Provide end-of-line resistors (if required) at the end of each alarm zone. Resistors shall be located in a wall junction box, 8'-0" AFF and labeled security resistor.

- E. Furnish 100 alarm decals (50 interior and 50 exterior), self-adhesive type to Owner.
- F. Fire Alarms:
  - 1. The security system shall be utilized to dial out all security and fire alarm signals. Fire alarm signals shall include alarm, trouble and supervisory conditions.
  - 2. Wiring between the fire alarm and security panel shall be installed in conduit.
- G. Tamper Circuits:
  - 1. It is the intent of the contract to provide tamper protection for all motion detectors, control units, and the cable.
  - 2. Any breaks or disconnects of cables or any tampering disturbances to motion detectors or control boxes shall trigger a system alarm.
- H. Area Junction Boxes:
  - 1. The Contractor shall install a minimum of seven (7) area junction boxes 12 x 12 x 4 with a hinged locking cover.
  - 2. The purpose of these junction boxes will be to provide a splice point between individual motion detectors and interface junction cabinet. Each cable pulled to these junction boxes shall have a minimum of three feet (3') of excess wire.
- I. Spare Capacity
  - 1. Provide four spare circuits for future portable classroom security devices.
- K. Network Interface
  - 1. Provide a network interface card to provide remote diagnostics and communications.

# 2.14 ELECTRICAL POWER

A. Primary power for the system control panel shall be obtained from the 120/208 volt AC power system, as indicated. A system circuit breaker shall be clearly marked *SECURITY ALARM* on the panel directory. The panel containing this breaker shall be equipped with a lockable hinged cover.

B. Secondary emergency power shall be provided by a battery integral with the security alarm control panel cabinet. The battery(ies) shall be rated for 10 hours of non-alarm 400 mA standby current.

C. Battery operation shall be automatic upon loss of primary power to the system.

D. Two (2) 120-volt NEMA 5-20R duplex receptacles shall be installed to allow direct plug-in connection of the subscriber's reporting control unit without extension cords.

E. Electrical power for the two (2) duplex receptacles shall be provided from an independent and separate 20 amp circuit breaker from emergency service equipment. Wiring shall be 2 # 12 + G run in 3/4" conduit from the panelboard to the receptacles.

F. Under no condition shall the circuit be integrated or made a part of the emergency lighting circuit.

G. Power is to be supplied from the 120-volt emergency service electrical panel.

H. Provide lock clip devices on circuit breakers serving power to security system equipment to prevent unintentional shutting *off* of power, but allowing tripping.

## 2.15 SURGE PROTECTION

A. Provide silicone avalanche lattice matrix solid state type surge protectors for each individual 120-volt circuit serving security alarm components. Also provide surge protection on phone line connections to automatic dialers.

B. All surge protectors shall be hard-wired and contained within enclosures. Plug-in units are **not acceptable**. Units shall be grounded per NEC and manufacturer's recommendations, and mounted adjacent to circuit source panel. Phone line protectors shall be mounted adjacent to the main control panel. Provide Transtector Systems Type ACP100BW3 (power) and ACP100PR Series (phone), or approved equal by Ditek or others.

## PART 3 - EXECUTION

## 3.1 GENERAL:

A. Installation shall be supervised and tested by the Manufacturer-authorized installer of the system equipment. The work shall be performed by skilled technicians under the direction of experienced engineer, all of whom shall be properly trained and qualified for this work.

## 3.2 WIRING

A. Conduit: Conduits shall be installed as required to conceal wiring in walls for keypads and motion detectors. Provide a complete conduit system for all security cabling.

B. Wire and Cable: All wiring shall be installed concealed above accessible ceiling and in walls. Conductors shall be carefully cabled and laced. Individual conductors shall be tagged with E-Z Code Markers indicating circuit number and type. Markers shall be used on all conductors at each outlet or pull box at each equipment enclosure.

C. Each conductor used for the same specific function shall be distinctively color-coded. Two different color codes shall be used for initiating device circuits. Two separate colors shall be used for the alarm bell circuit. Power supply and wiring connecting the secondary source of power shall be as indicated.

D. All 120-volt connections for security alarm system shall be made from emergency panels only.

E. Provide a 3/4-inch conduit to the main telephone backboard from the automatic telephone dialer for telephone wiring. Provide all station wiring and jacks.

F. All concealed conduit and junction boxes for security system shall be painted blue with permanent methods for quick field identification in all areas.

G. No power supplies shall be installed above ceilings. All shall be installed in electrical wiring closets or electrical rooms. Provide labeled circuit breakers with lock-on clips.

H. Install power supplies and other auxiliary components for detection devices at control units, unless otherwise indicated. Do not install such items near the devices they serve. Provide tamper switches where mounted separately from control units.

I. Alarm conductor terminations in control panels shall be made on terminal strips with separate point for each conductors. All such strips to be number-identified as shown in wiring diagram attached to inside of door of control panel. Connect wiring neatly to terminal strips. Lace wiring with nylon cable straps. Set up termination of cabling so that sections of the system may be isolated or shorted out of servicing.

J. Ground system components and conductor cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

# 3.3 INSTALLATION

A. Alarm conductor terminations in control panels shall be made on terminal strips with separate point for each conductors. All such strips to be number identified as shown in wiring diagram attached to inside of the door of the control panel. Connect wiring neatly to the terminal strips. Lace wiring with nylon cable straps. Set up termination of cabling so that sections of the system may be isolated or shorted out of servicing.

B. From the digital communicator, provide conduit wiring and connections of telephone company equipment. Provide Category 3 telephone line interface equipment compatible with telephone company equipment.

C. All outlet and mounting boxes required as apart of the mounting arrangements for devices, control cabinets, and signals shall be in accordance with the manufacturers' Specifications, and shall be installed as directed by the manufacturers' instructions and diagrams. All equipment shall be installed at the location and heights shown on the drawings or as directed by the Architect.

D. Test completed system in presence of Owner's representative, Architect, Consulting Engineer, General Contractor, and Manufacturer's technical representative. Upon completion of a successful test of the system, the Electrical Contractor shall so certify in writing to the Owner, the Architect, and the General Contractor.

E. Warrant the alarm system, including equipment and wiring, free from inherent electrical and mechanical defects for a period of one year form the date of Owner's acceptance of the system.

F. Equipment manufacturer shall provide a gratis testing and inspection contract during the warranty period, with option for paid extension at expiration of the gratis period.

G. Provide end of line resistors at the end of each alarm zone. Resistors shall be located in an electrical wall junction box and labeled *security resistor*. The cover shall be painted blue.

H. Mounting height for individual devices shall be as follows (above finished floor):

- 1. Motion Detectors 8 feet (6" below clg if less than 8 feet).
- 2. Remote Arming Stations 54 inches.
- 3. Interior Sirens 8 feet or above lay-in ceiling tiles.
- 4. Exterior Sirens 12 feet.

## 3.4 TESTING, GUARANTEE, SERVICE

A. Prior to installation of any equipment, the Contractor shall provide the Engineer with copies of submittals for approval. Submittals shall include typical one-line risers and equipment specification sheets.

B. The Contractor is responsible for assuring that conduit size and wire quantity, size, and type are suitable for the equipment supplied. The Contractor shall review the proper installation of each type of device with the equipment supplier. Final connections between the wiring and equipment shall be made under the supervision of the equipment supplier's representative.

C. Upon completion, the Contractor shall conduct a functional test of the System for the Owner, Architect, and Engineer. To assure that wire size, power supply, number of devices on a circuit, etc., are suitable to support 100% of devices being in alarm or operated simultaneously, this test shall include the following:

- 1. Place all sensors, modules, and devices in alarm. Each shall display its address and alarm condition at both the control panel and the keypads.
- 2. Reset all alarmed and operated devices. The panel shall display the address of any off-normal devices.

D. All components, parts, and assemblies supplied by the Manufacturer shall be guaranteed against defects in materials and workmanship for a period of 24 months.

E. The equipment manufacturer shall have a local branch office staffed with trained, full-time employees who are capable of performing testing, inspection, repair, and maintenance services for the life of the System.

F. All testing shall be coordinated with and approved by the engineer. A letter certifying that the installation is complete and fully operable shall be forwarded to the Engineer. The Contractor and an authorized representative from each supplier of equipment shall be in attendance to make necessary adjustments related to the testing.

- G. As minimum requirements, the system shall be tested to show that:
  - 1. The complete system is free from grounded or open circuits.
  - 2. Each alarm initiating device functions as specified and produces the specified alarm actions.
  - 3. Abnormal condition of any circuit device required to be electrically supervised shall result in the specified trouble signals.
  - 4. The emergency power source is capable of operating the system.
  - 5. The system shall be operable under the specified trouble conditions.
  - 6. Any test such as loss of power supplies, will initiate the proper system response in compliance with specification.
  - 7. All addresses of devices are reported correctly and to Owner's nomenclature and satisfaction.
  - 8. All addressable functions described are sounded and/or executed as programmed upon particular alarm conditions, etc.
  - 9. All auxiliary functions are executed correctly, completely and as required.
  - 10. Autodialer has successfully contacted the UL Central Station and transmitted all signal conditions.

H. Upon completion of the security system installation, the alarm system installing contractor will demonstrate the functions and operations to the Owner's security system representatives. All devices are to be activated during the test. The demonstration will be held after hours when the building is unoccupied.

I. It is incumbent upon the contractor to have tested all security alarm devices and walk-tested the total system prior to the demonstration.

J. Failure of any part of the alarm system will result in a non-acceptance of the installation.

K. Future demonstration walk-tests will be done at a time and date convenient to the school.

# 3.5 COORDINATION OF MAINTENANCE, MONITORING, AND PROGRAMMING

A. It shall be the responsibility of the Representative of the Equipment Manufacturer to arrange for meetings between the Owner's Representatives and the Representatives of the qualified companies who specialize in the maintenance, testing, and central station monitoring of Security Systems.

B. Programming shall conform to Modem IIIa format with definable zones reporting as required to the Owner's service provider's central station. No lockout codes are acceptable.

## 3.6 GUARANTEE

A. Upon completion of the system installation and before final inspection, thoroughly check the detection system. Certify in a letter to the Architect that each detector, all devices, and the complete system have been checked and are as specified, that all items have been labeled, that as-built wiring diagrams have been prepared, and that the Owner's representatives have been instructed in the detection system.

## 3.7 DEMONSTRATION AND TRAINING

A. Provide a trained factory-authorized technician for on-site instruction of Owner's personnel in the proper programming, operation, maintenance and use of the equipment. Training and instruction shall be held

at the project site, following Owner-acceptance and all final tests and adjustments. Training shall be minimum of eight (8) hours.

# 3.8 KEYS

A. Keys and locks for all equipment shall be identical. Not less than six (6) keys shall be provided. Keys shall be identified by an appropriate number stamped on the key or on a metal tag attached thereto.

# 3.9 RECORD DRAWINGS AND DOCUMENTS

A. The Contractor shall furnish three (3) copies of all plans, drawings and schematics to the owner after the acceptance test. The drawings shall show all terminal cabinets, devices, wiring and conduit routings.

B. The alarm installing contractor must provide, directly to the project electrical engineer, a 1/8" scale *asbuilt* schematic drawings of the complete security system installation indicating:

- 1. Building Layout Interior and Exterior Floor Plan.
- 2. Room Location, Names and Numbers.
- 3. Device Equipment Connection Points, Color-Coded.
- 4. Device Locations.
- 5. Interface Junction Cabinet.
- 6. Area Junction and Splice Boxes.

C. Project Record Documents: Provide for the security system, in addition to documents required by Section 16010, three Record and Information Booklets containing a description of the system, operating and maintenance instructions on each piece of equipment, including descriptive bulletin and parts lists. Booklet shall be a three-ring looseleaf binder on  $8-1/2" \times 11"$  sheets and shall contain name, address, and loose-leaf binder on  $8-1/2" \times 11"$  sheets and shall contain name, address, and loose-leaf binder on  $8-1/2" \times 11"$  sheets and shall contain name, address, and telephone number of the local representative of the equipment.

D. Provide 8-1/2" x 11" building room layout based on the contract drawings in a suitable frame with plexiglass panel, indicating intrusion zones and all intrusion detectors. Install adjacent to the intrusion alarm control panel.

## 3.10 ADJUSTING

A. Occupancy Adjustment: When requested, within twelve (12) months of date of substantial completion, provide on-site assistance in adjusting and reprogramming to suit actual occupied conditions. Provide up to two visits per Project for this purpose without additional cost.

# END OF SECTION

# **SECTION 283111**

#### FIRE ALARM SYSTEM (ADDRESSABLE TYPE)

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fire-alarm control unit.
  - 2. Manual fire-alarm boxes.
  - 3. System smoke detectors.
  - 4. Heat detectors.
  - 5. Carbon monoxide detectors.
  - 6. Notification appliances.
  - 7. Device guards.
  - 8. Magnetic door holders.
  - 9. Remote annunciator.
  - 10. Graphic annunciator.
  - 11. Addressable interface device.
  - 12. Digital alarm communicator transmitter.
- B. Related Requirements:
  - 1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

#### 1.3 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
  - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, and electrical characteristics.

- B. Shop Drawings: For fire-alarm system.
  - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
  - 2. Include plans, elevations, sections, details, and attachments to other work.
  - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
  - 4. Detail assembly and support requirements.
  - 5. Include voltage drop calculations for notification-appliance circuits.
  - 6. Include battery-size calculations.
  - 7. Include input/output matrix.
  - 8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
  - 9. Include performance parameters and installation details for each detector.
  - 10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
  - 11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
  - 12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
    - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    - b. Show field wiring required for HVAC unit shutdown on alarm.
    - c. Locate detectors according to manufacturer's written recommendations.
    - d. Show air-sampling detector pipe routing.
  - 13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
  - 14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- C. General Submittal Requirements:
  - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
  - 2. Shop Drawings shall be prepared by persons with the following qualifications:
    - a. Trained and certified by manufacturer in fire-alarm system design.
    - b. NICET-certified, fire-alarm technician; Level III minimum.
    - c. Licensed or certified by authorities having jurisdiction, if required.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
- 1.6 Sample Warranty: For special warranty.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
    - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
    - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
    - d. Riser diagram.
    - e. Device addresses.
    - f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
    - g. Record copy of site-specific software.
    - h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
      - 1) Equipment tested.
      - 2) Frequency of testing of installed components.
      - 3) Frequency of inspection of installed components.
      - 4) Requirements and recommendations related to results of maintenance.
      - 5) Manufacturer's user training manuals.
    - i. Manufacturer's required maintenance related to system warranty requirements.
    - j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
  - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
  - 3. Smoke Detectors, Fire Detectors: Quantity equal to 10percent of amount of each type installed, but no fewer than one unit of each type.
  - 4. Detector Bases: Quantity equal to [two] <Insert number> percent of amount of each type installed, but no fewer than one unit of each type.

- 5. Keys and Tools: Six extra set for access to locked or tamperproofed components.
- 6. Audible and Visual Notification Appliances: [One] <Insert number> of each type installed.
- 7. Fuses: [Two] <Insert number> of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
- 8. Filters for Air-Sampling Detectors: Quantity equal to [two] <Insert number> percent of amount of each type installed, but no fewer than one unit of each type.
- 9. Air-Sampling Fan: Quantity equal to [one] <Insert number> for every five detectors, but no fewer than one unit of each type.
- 10. Two (2) additional circuit boards for Fire Alarm Control Panel.

#### 1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

#### 1.10 PROJECT CONDITIONS

- A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
- B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

#### 1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
  - 2. Warranty Period: Two (2) years from date of Substantial Completion.

## PART 2 - PRODUCTS

#### 2.1 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: Provide a digital, addressable fire alarm system by Silent Night Farenheit. No other manufacturers will be accepted. All appliances shall be of the same manufacturer as the Fire Alarm Control Panel specified to assure absolute compatibility between the appliances and the control panels, and to assure that the application of the appliances is done in accordance with the single manufacturer's instructions.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/strobe evacuation.
- C. Automatic sensitivity control of certain smoke detectors.

- D. All components provided shall be listed for use with the selected system.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
  - 1. Manual stations.
  - 2. Heat detectors.
  - 3. Flame detectors.
  - 4. Smoke detectors.
  - 5. Duct smoke detectors.
  - 6. Carbon monoxide detectors.
  - 7. Combustible gas detectors.
  - 8. Automatic sprinkler system water flow.
  - 9. Preaction system.
  - 10. Fire-extinguishing system operation.
  - 11. Fire standpipe system.
  - 12. Dry system pressure flow switch.
  - 13. Fire pump running.
- B. Fire-alarm signal shall initiate the following actions:
  - 1. Continuously operate alarm notification appliances, including voice evacuation notices.
  - 2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
  - 3. Transmit an alarm signal to the remote alarm receiving station.
  - 4. Unlock electric door locks in designated egress paths.
  - 5. Release fire and smoke doors held open by magnetic door holders.
  - 6. Activate voice/alarm communication system.
  - 7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
  - 8. Activate preaction system.
  - 9. Recall elevators to primary or alternate recall floors.
  - 10. Activate elevator power shunt trip.
  - 11. Record events in the system memory.
  - 12. Indicate device in alarm on the graphic annunciator.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
  - 1. Valve supervisory switch.
  - 2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
  - 3. Alert and Action signals of air-sampling detector system.
  - 4. Elevator shunt-trip supervision.
  - 5. Fire pump running.
  - 6. Fire-pump loss of power.
  - 7. Fire-pump power phase reversal.
  - 8. User disabling of zones or individual devices.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
  - 1. Open circuits, shorts, and grounds in designated circuits.

- 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
- 3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
- 4. Loss of primary power at fire-alarm control unit.
- 5. Ground or a single break in internal circuits of fire-alarm control unit.
- 6. Abnormal ac voltage at fire-alarm control unit.
- 7. Break in standby battery circuitry.
- 8. Failure of battery charging.
- 9. Abnormal position of any switch at fire-alarm control unit or annunciator.
- 10. Voice signal amplifier failure.
- E. System Supervisory Signal Actions:
  - 1. Initiate notification appliances.
  - 2. Identify specific device initiating the event at fire-alarm control unit, and remote annunciators.
  - 3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
  - 4. Transmit system status to building management system.
  - 5. Display system status on graphic annunciator.
- F. The system program shall meet the requirements of this project, current codes and standards, and satisfy the Office of Life Safety.

#### 2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

#### 2.4 FIRE-ALARM CONTROL UNIT

- A. General Requirements for Fire-Alarm Control Unit:
  - 1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
    - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    - b. Include a real-time clock for time annotation of events on the event recorder and printer.
    - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
    - d. The FACP shall be listed for connection to a central-station signaling system service.
    - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

- 2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
- 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
  - 1. Annunciator and Display: Liquid-crystal type, two line(s) of 40 characters, minimum.
  - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- C. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
  - 1. Pathway Class Designations: NFPA 72, Class B.
  - 2. Pathway Survivability: Level 0.
  - Install no more than 50 addressable devices on each signaling-line circuit. Device loading shall not exceed 80% of circuit capacity in order to leave space for future devices.
  - 4. Serial Interfaces:
    - a. One dedicated RS 485 port for central-station operation using point ID DACT.
    - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
    - c. One RS 232 port for voice evacuation interface.
- D. Smoke-Alarm Verification:
  - 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
  - 2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
  - 3. Sound general alarm if the alarm is verified.
  - 4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- E. Notification-Appliance Circuit:
  - 1. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- F. Elevator Recall:
  - 1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
    - a. Elevator lobby detectors except the lobby detector on the designated floor.
      - b. Smoke detector in elevator machine room.
      - c. Smoke detectors in elevator hoistway.
  - 2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
  - 3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
- G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

- H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivityadjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- J. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.
  - 1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
    - a. Allow the application of, and evacuation signal to eight fully digitized and multiplexed audio channels (zones) and, at the same time, allow voice paging to the other zones selectively or in any combination.
    - b. Programmable tone and message sequence selection.
    - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
    - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.
  - 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones.
  - 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
  - 4. The Digital Message Unit shall be provide up to 32 minutes of pre-recorded emergency messaging. The message contained in the fully digital message unit shall be recordable in the field on a computer.
- K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. The system shall be arranged to receive power from one three wire 120 Vac, 15 A supply. All low voltage operation shall be provided from the fire alarm control panel. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
  - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the powersupply module rating.
  - 2. All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel
- L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
  - 1. Batteries: Sealed lead calcium.
  - 2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of twenty-four (24) hours with 5 minutes of alarm operation at the end of this period, or as required by the Authority Having Jurisdiction and Applicable codes. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic.

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

#### 2.5 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
  - 1. Single-action mechanism,pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
  - 2. Station Reset: Key- or wrench-operated switch.
  - 3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

#### 2.6 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
  - 1. Comply with UL 268; operating at 24-V dc, nominal.
  - 2. Detectors shall be four-wire type.
  - 3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
  - 4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
  - 5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
- B. Photoelectric Smoke Detectors:
  - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.
    - d. Present sensitivity selected.
    - e. Sensor range (normal, dirty, etc.).
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
  - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.

- d. Present sensitivity selected.
- e. Sensor range (normal, dirty, etc.).
- 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
- 4. Each sensor shall have multiple levels of detection sensitivity.
- 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
- 6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.
- 7. Provide remote test station with LED indicators for each duct detector, mounted in an accessible location flush in ceiling, or wall mounted 7'6" AFF. Field coordinate exact location. Provide with white faceplate.

#### 2.7 CARBON MONOXIDE DETECTORS

- A. General: Carbon monoxide detector listed for connection to fire-alarm system.
  - 1. Mounting: Adapter plate for outlet box mounting.
  - 2. Testable by introducing test carbon monoxide into the sensing cell.
  - 3. Detector shall provide alarm contacts and trouble contacts.
  - 4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
  - 5. Comply with UL 2075.
  - 6. Locate, mount, and wire according to manufacturer's written instructions.
  - 7. Provide means for addressable connection to fire-alarm system.
  - 8. Test button simulates an alarm condition.

#### 2.8 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
  - 1. Temperature sensors shall test for and communicate the sensitivity range of the device.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
  - 1. MountingTwist-lock base interchangeable with smoke-detector bases.
  - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

#### 2.9 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
  - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

- B. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
  - 1. Rated Light Output:
    - a. 15/30/75/110 cd, selectable in the field.
  - 2. Mounting: Wall or ceiling mounted as noted on the drawings.
  - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
  - 4. Flashing shall be in a temporal pattern, synchronized with other units.
  - 5. Strobe Leads: Factory connected to screw terminals.
  - 6. Mounting Faceplate: Factory finished, red for wall mounted devices, white for ceiling mounted devices.
- C. Voice/Tone Notification Appliances:
  - 1. Comply with UL 1480.
  - 2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
  - 3. High-Range Units: Rated 2 to 15 W.
  - 4. Low-Range Units: Rating adjustable between 1/4W, 1/2W, 1W and 2W.
  - 5. Mounting: Flush, ceiling or wall mounted as indicated on the drawings.
  - 6. Matching Transformers: Tap range matched to acoustical environment of speaker location.
  - 7. Reentrant Speakers: Re-entrant speakers shall have a white housing. Power taps shall be provided at 2w, 4w, 8w, and 15w. Re-entrant speakers shall provide 102 dBA peak sound output at 15w. A metal compression driver shall be inherent to the re-entrant speaker. Cone type drivers are not acceptable. Provide weatherproof wall boxes for outdoor mounting.

## 2.10 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
  - 1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
  - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  - 3. Rating: 24-V ac or dc.
- B. Material and Finish: Match door hardware.

## 2.11 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing. An enable/disable password shall be provided to ensure only authorized personnel can use the control switches.
  - 1. Mounting: Flush cabinet, NEMA 250, Type 1.

- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.
- C. Provide a graphic drawing of the entire facility showing all barriers, rooms and room numbers so that it is easy to correlate the LCD text with the graphic display ensuring timely response to an alarm. The graphic display shall be mounted in a picture frame and placed above the LCD annunciator. Submit the drawing for engineer approval.

### 2.12 ADDRESSABLE INTERFACE DEVICE

- A. General:
  - 1. Include address-setting means on the module.
  - 2. Store an internal identifying code for control panel use to identify the module type.
  - 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts. Provide for each sprinkler tamper switch, flow alarm, and smoke damper assembly.
- C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall, and to circuit-breaker shunt trip for power shutdown.
  - 1. Allow the control panel to switch the relay contacts on command.
  - 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module:
  - 1. Operate notification devices.
  - 2. Operate solenoids for use in sprinkler service.
  - 3. Other control functions, including mute local sound systems and unlock access control system doors.

#### 2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. IP/Cellular based communicator transmitter shall be Honeywell IPGSM-4G or as directed by FCPS, acceptable to the remote central station and shall comply with UL 864/NFPA. Contractor shall program and test with communicator contact ID reporting. Provide external antenna and cable. Power connections shall be made to communicator via Fire Alarm Control Panel.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from firealarm control unit and automatically capture and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of IP/Cellular line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report service restoration to the central station. If service is lost on both IP/Cellular lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:

- 1. Verification that both IP/Cellular lines are available.
- 2. Programming device.
- 3. LED display.
- 4. Manual test report function and manual transmission clear indication.
- 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
  - 1. Address of the alarm-initiating device.
  - 2. Address of the supervisory signal.
  - 3. Address of the trouble-initiating device.
  - 4. Loss of ac supply.
  - 5. Loss of power.
  - 6. Low battery.
  - 7. Abnormal test signal.
  - 8. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

#### 2.14 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
  - 1. Factory fabricated and furnished by device manufacturer.
  - 2. Finish: Paint of color to match the protected device.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
  - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

- 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
- 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- 3. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
  - 1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Manual Fire-Alarm Boxes:
  - 1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
  - 2. Mount manual fire-alarm box on a background of a contrasting color.
  - 3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- D. Smoke- or Heat-Detector Spacing:
  - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
  - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
  - 3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
  - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
  - 5. HVAČ: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
  - 6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends. Turn over to mechanical contractor for installation in ductwork.
  - 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- G. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- I. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.
- K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

#### 3.3 PATHWAYS

- A. The Fire Alarm System shall be installed in dedicated conduit, except fire rated type MC cable may be used where concealed above accessible ceilings. The entire system shall be installed in a skillful manner in accordance with approved manufacturers' manuals and wiring diagrams. The Contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the NEC, approved by local authorities having jurisdiction for the purpose.
- B. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.

#### 3.4 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
  - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
  - 1. Smoke dampers in air ducts of designated HVAC duct systems.
  - 2. Magnetically held-open doors.
  - 3. Electronically locked doors and access gates.
  - 4. Alarm-initiating connection to elevator recall system and components.
  - 5. Alarm-initiating connection to activate emergency lighting control.
  - 6. Supervisory connections at valve supervisory switches.
  - 7. Supervisory connections at elevator shunt-trip breaker.
  - 8. Data communication circuits for connection to building management system.
  - 9. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
  - 10. Supervisory connections at fire-pump engine control panel.
- C. End of Line Resistors shall be furnished as required by the manufacturer, mounted using stakon connectors.

#### 3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

#### 3.6 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

### 3.7 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Visual Inspection: Conduct visual inspection prior to testing.
    - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
  - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
  - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
  - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
  - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

- G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

#### 3.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- B. The Factory Trained and Authorized Fire Alarm Vendor who installed this system shall provide a separate maintenance contract for a period of three (3) years from the date of system commissioning.

#### 3.9 DEMONSTRATION

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

## SECTION 31 10 00 - CLEARING

#### PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract including General and Supplementary Conditions, and Division 1, Specification Sections apply to work in this section.

#### 1.2 DESCRIPTION OF WORK

A. This section specifies materials and work required to clear the project site.

#### 1.3 RELATED WORK

A. Refer to Section 31 20 00 "Earthmoving"

## 1.4 STANDARDS

A. Maryland Standards and Specifications for Soil Erosion and Sediment Control, current edition.

#### 1.5 PROJECT CONDITIONS

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Existing Utilities: The locations of all existing utilities are approximate. These locations have been determined from field survey, public utility records and Owner records.
  - 1. The Contractor shall be responsible for contacting "Miss Utility" and all Owner's or controlling agencies of existing utilities within the construction area for verification of locations, prior to beginning of work.
  - 2. The Contractor shall be responsible for coordination of utility relocation or removal by others with all phases of construction activities.

### 1.6 SUBMITTALS

A. Submit written notification to public utility companies, at least one week prior to planned work, for disconnection of active utilities.

## 1.7 DEFINITIONS

A. Topsoil: A friable loam surface soil, free of subsoil, clay, lumps, weeds, roots, debris and stones exceeding one inch in any dimension.

## 1.8 CONSTRUCTION SURVEYS

A. Provide survey equipment and qualified personnel for construction surveys. Provide stakes and/or flag trees to designate the limits of clearing operations.

## PART 2 - PRODUCTS

## 2.1 TEMPORARY TREE PROTECTION FENCING

- A. In accordance with Maryland Standards and Specifications for Soil Erosion and Sediment Control, current edition, and as indicated.
- B. Fence Posts: Steel "T" or "U" channel, with punched or riveted lugs for fence attachment.
  - 1. Weight: 1.33 pounds per linear foot
  - 2. Length: 66 inches
  - 3. Bottom End Shape: Pointed
  - 4. Finish: Rust inhibitive primer paint
- C. Contractor's Option: Hardwood posts, two by two inches by 66 inches long, with pointed bottom ends.
- D. Fence Fabric: Tensar Safety Barricade, manufactured by the Tensar Corporation, Morrow, Georgia.
  - 1. Fabric Height: Four feet
  - 2. Color: Safety Orange
- E. Contractor's Option: Standard snow fence, used with steel posts.

## PART 3 - EXECUTION

- 3.1 PROTECTION AND RESTORATION
  - A. Refer to Section 31 20 00 "Earthmoving" and as noted.
  - B. Existing Trees: Protect existing trees, indicated "To Remain", and existing trees beyond the indicated "Clearing and Grading Limits" from the following:
    - 1. Cutting, breaking or skinning roots.
    - 2. Skinning or bruising bark.
    - 3. Stockpiling earth materials within drip line.
    - 4. Stockpiling construction materials within drip line.
    - 5. Vehicle parking within drip line.
    - 6. Excessive pedestrian or vehicular traffic.
  - C. Temporary Tree Protection Fencing: Provide "Temporary Tree Protection" for trees indicated to remain, and as required for existing trees beyond the indicated "Clearing and Grading Limits". Install as indicated or required in accordance with the standards of the "Maryland Standards and Specifications for Soil Erosion and Sediment Control", and as noted.
    - 1. Install posts, spaced no more than 6 feet on center, by driving plumb to 18-inch depth. Stretch fence fabric between posts and fasten securely to steel posts with tie wire. Fastenings for hardwood posts shall be tie wire or staples.
  - D. The Contractor shall provide a 'Watering Plan' submittal that identifies the frequency and rate of watering for review and approval. This will be required for all trees indicated "To Remain" during clearing and subsequent construction operations.
  - E. Repair or remove and replace trees indicated "To Remain" or located beyond the indicated "Clearing and Grading Limits" and damaged by clearing or subsequent construction

operations, with new trees of equal species, caliper and quality, as directed by the Architect, at no increase to contract sum.

## 3.2 CLEARING

A. Clear the project site, removing trees and vegetation, within "Clearing and Grading Limits" indicated.

#### 3.3 GRUBBING

A. Completely remove stumps, roots and debris, within "Clearing and Grading Limits" indicated, to minimum 12-inch depth below existing ground surface. Employ manual methods for grubbing around trees indicated "To Remain".

#### 3.4 TOPSOIL STRIPPING

- A. Strip topsoil, within "Clearing and Grading Limits" indicated. Remove heavy vegetation growth before stripping. Strip topsoil to all depths encountered. Strip topsoil to prevent intermingling with tree roots underlying subsoil.
  - 1. Do not strip topsoil within the drip line of existing trees indicated "To Remain", or located beyond the indicated "Clearing and Grading Limits".
- B. Stockpile topsoil, at locations approved by the Architect, until required for landscape development. Shape and grade stockpiles to prevent surface water ponding. Temporarily stabilize stockpiles as specified on the Soil Erosion and Sediment Control Drawings.

### 3.5 WASTE MANAGEMENT

A. Transport combustible and non-combustible waste materials from the project site to legal offsite disposal areas. Document legal offsite waste disposal areas. Burning of waste materials is prohibited.

## SECTION 31 20 00 - EARTHMOVING

### PART 1 - GENERAL

#### 1.1 RELATED DRAWINGS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 1, Specification Sections, apply to work in this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section specifies materials, equipment and work required to perform earthwork and grading operations for site development.
- 1.3 TESTING AND INSPECTIONS
  - A. The Owner shall be responsible for providing a Maryland Registered Professional Soils Engineer for required testing and inspections.
  - B. Services of the Soils Engineer will not necessarily be on a full time basis, but will include the number of visits and tests required to observe the performance of all earthwork under this Section. If in the opinion of the Soils Engineer, any work performed under this Section does not meet the technical or design requirements stipulated for the work, the Contractor shall make all necessary readjustments to his approval.
  - C. All earthwork procedures shall be performed in the presence of the Soils Engineer. Give adequate (24 hours) notice when Soils Engineer's services are required.

## 1.4 RELATED WORK

A. Refer to Section 31 10 00 "Clearing".

## 1.5 CODES

A. Contractor shall comply with the applicable requirements of the governing agencies having jurisdiction.

#### 1.6 **DEFINITIONS**

- A. Excavation: Removal of earth materials to subgrade elevations indicated or specified.
- B. Over-Excavation: Removal of earth materials, beyond subgrade elevations indicated or specified, without written authorization from the Architect.
- C. Unsuitable Earth: Soft or unstable earth materials beyond limits of excavation indicated (e.g. muck, soft clays, organic soils, peat, etc.).
- D. Fill: Placement of earth materials over existing ground surfaces to subgrade elevations indicated or specified.
- E. Backfill: Placement of earth materials in excavations to subgrade elevations indicated or specified.

- F. Soils Engineer: Shall be a Licensed Professional Engineer, currently registered in the State of Maryland, or shall be an authorized representative of such an engineer.
- G. Rock: Defined as material that cannot be dislodged by a Caterpillar Model No. D-8N, heavy duty track-type tractor, rated at not less than 285 hp flywheel power and equipped with a single shank hydraulic ripper, capable of exerting not less than 45,000 lbs breakout force. Rock excavation includes up to 6-inches over-excavation below the required excavation depth. This definition of rock does not include materials such as hardpan, loose rock, concrete or other materials that can be removed by means other than drilling and blasting, but which for reasons of economy in excavating the Contractor chooses to remove by drilling and blasting.

## 1.7 SUBMITTALS

- A. Density Test Results: The Contractor shall submit copies of the results of the specified density testing to the Owner's Representative for review and approval.
- B. . LEED Submittals: Comply with Section 018113
  - 1. MR Credit 3: BPDO Sourcing of Raw Materials
    - a. For recycled content site fill or aggregate: Documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include material cost value.
    - b. For regionally sourced site fill or aggregate: Documentation indicating locations of recovery, manufacture, purchase of recycled raw materials.

## 1.8 PROJECT CONDITIONS

- A. Existing Subsurface Conditions: All excavation materials shall be "unclassified".
- B. Existing Utilities: The locations of all existing utilities are approximate. These locations have been determined from field survey, public utility records and Owner records.
  - a. The Contractor shall be responsible for contacting "Miss Utility" and all Owner's or controlling agencies of existing utilities within the construction area for verification of locations, prior to beginning of work.
  - b. The Contractor shall be responsible for coordination of utility relocation or removal by others with all phases of construction activities.

## 1.9 CONSTRUCTION SURVEYS

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined vertical and horizontal stakes required to perform earthwork operations to subgrade elevations indicated or specified.

## 1.10 EARTHWORK BALANCE

- A. Perform all earthwork operations regardless of actual quantities encountered.
  - 1. Excess materials shall be legally disposed of off project property.
  - 2. Off-site borrow shall be provided at no increase to the Contract sum.

## PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. Provide products manufactured and of primary raw materials extracted/recovered within a 500-mile radius of the project site.
- B. Fill Materials: Soils used as fill materials shall have Unified Soils Classification (ASTM D 2487) of ML or better, but shall exclude highly plastic clays or silts (MH-CH). Soil material for fill shall be free of organic matter or debris, waste materials, frozen materials, vegetable matter and rock or stones exceeding three inches in any dimension. No more than 15 percent of rocks or lumps shall be larger than 2½ inches in any dimension. Materials shall be non-frost susceptible soils, and shall have a liquid limit of less than 40 and a plasticity index of less than 12.
  - 1. Fill material used within the top 12 inches of fill shall be free of rocks or stones exceeding one inch in any dimension.
  - 2. Recycled concrete (RC-6) subbase may be used as fill material, except under building slab.
- C. Backfill Material: As indicated for fill material.
- D. Borrow Material: Off-site borrow, if required, shall be as specified for Fill Materials. Obtain and transport borrow material at no increase to the Contract sum.

## PART 3 - EXECUTION

## 3.1 PROTECTION AND RESTORATION

- A. General: Provide protection to prevent settlement, movement, undermining of or erosion to existing site improvements, existing utilities, existing buildings, new site improvements, new buildings and new utilities.
- B. Do not permit heavy equipment to pass over any utility until a minimum of two feet of compacted fill or backfill is placed over the top of utility.
- C. Restore damage, at no increase to Contract sum, resulting from the lack of protection or improper installation of protective measures or careless execution of construction activities. Restoration work to be approved by the Soils Engineer and Owner's Representative.

#### 3.2 EXISTING UTILITIES

- A. Notify all public utility companies, 48 hours prior to the start of earthwork operations. Verify and mark horizontal utility locations prior to the start of earthwork operation. Manually excavate and expose utilities as earthwork operations approach marked locations.
- B. Immediately notify the Owner's Representative or the Architect in the event horizontal or vertical utility locations differ from locations indicated. Provide horizontal and vertical details of utility locations as directed by the Owner's Representative or the Architect. Conflicts with construction to be determined by the Owner's Representative or the Architect. Payment for correction of unforeseen conflicts with construction shall be by change order.

- C. Coordinate public utility relocation work required for public utilities conflicting with construction. The Owner's Representative or the Architect will provide directions and details required to relocate utilities conflicting with construction.
- D. Do not disconnect or interrupt existing utilities serving existing facilities to remain without notification and authorization of the Architect or the Owner's representatives.

## 3.3 DEWATERING

A. Perform earthwork and grading operations to prevent surface or subsurface water from flowing into excavations, surface or subsurface water from flooding project site or adjacent property and water accumulations detrimental to stability of subgrades. Provide, install, operate and maintain all required pumps, sumps, discharge lines and related equipment.

## 3.4 EXCAVATION

- A. Excavate materials encountered to subgrade elevations indicated or specified. All excavation is unclassified. Excavate materials regardless of the character of the materials encountered, at no increase to contract sum.
- B. Blasting Blasting on this site is acceptable, provided it is performed in accordance with MDOT-SHA Standards and Specifications. Specifically section TC-6.07. In addition, the Contractor shall coordinate all blasting efforts with the Owner so as not to impact the User. Lastly, the Contractor shall be responsible for all impacts that blasting has on the adjacent buildings.
- C. Subgrade Preparation: Upon completion of excavation activities, exposed subgrade shall be proofrolled utilizing a minimum 10-ton roller, in the presence of the Soils Engineer. Proofrolling shall not be performed during or following wet weather conditions. Any unsuitable materials discovered during proofrolling operations shall be removed and replaced as specified below. Upon completion of proofrolling activities and approval of the subgrade by the Soils Engineer, exposed subgrade shall be further prepared as follows:
  - 1. Unpaved Areas: Scarify subgrade to six-inch depth prior to topsoil placement.
  - 2. Paved Areas: Scarify subgrade to twelve-inch depth and compact to 98 percent maximum dry density, compact the top 18" to 100% maximum dry density. Density test methods: ASTM D 698. Remove unsuitable earth, exhibiting excessive weaving during compaction operations, as specified.

## 3.5 OVER-EXCAVATION

A. Correct over-excavated areas as directed by the Soils Engineer. Remove unsuitable earth encountered as a direct result of over-excavation. Excavate and dispose of all unsuitable earth. Correct excavated area as directed.

## 3.6 UNSUITABLE EARTH

A. Immediately notify the Owner's Representative or the Architect, and Soils Engineer in the event unsuitable earth is encountered during earthwork or subsequent construction operations. Stop all work within immediate area of unsuitable earth. Do not remove unsuitable earth until written authorization is obtained from the Owner's Representative and proper measurements are obtained. Excavate and dispose of all unsuitable earth upon receipt of written authorization from the Owner's Representative. Backfill excavated area as specified. Payment for unsuitable earth removal and associated backfill operations to be by change order.

## 3.7 EXCAVATED MATERIAL STORAGE

- A. Stockpile select excavated materials required for fill and/or backfill operations. Stockpile locations are shown on the drawings and the stockpiles are not to exceed the plan view areas shown on the drawings. All Stockpile locations are to be approved by the Construction Manager. Shape and grade stockpiles to prevent ponding of surface water. Temporarily stabilize stockpiles as specified on Soil Erosion and Sediment Control Drawings. Dispose of excess excavation materials as specified.
  - 1. Excess excavated material shall be legally disposed of by removal from the project site.

## 3.8 EARTH FILL

- A. Existing Ground Surface Preparation: Remove vegetation and topsoil as specified in Section 31 10 00 "Clearing". Proofroll exposed subgrade utilizing a heavily loaded dump truck or other pneumatic-tired vehicle of similar size and weight, in the presence of the Soils Engineer. Proofrolling shall not be performed during or following wet weather conditions.
- B. Existing Subgrade Preparation: Remove unsuitable earth, upon completion of clearing and proofrolling operations, as specified. Continuously bench existing slopes exceeding four feet horizontal to one foot vertical. Bench sufficiently to accommodate earthmoving and compaction equipment. Select material, removed as a result of benching operations, may be used for fill and/or backfill as specified.
  - 1. Unpaved Areas: Scarify existing subgrade to six-inch depth and compact to 90 percent maximum dry density. Density test method: ASTM D 698.
  - 2. Paved Areas: Scarify existing subgrade to twelve-inch depth and compact to 98 percent maximum dry density, compact the top 18" to 100% maximum dry density. Density test method: ASTM D 698. Remove unsuitable earth, exhibiting excessive weaving during compaction operations, as specified.
- C. Fill Placement: Do not place fill material on frozen or muddy subgrades.
  - 1. Unpaved Areas: Place fill material in loose lifts not exceeding eight-inches.
  - 2. Paved Areas: Place fill material in loose lifts not exceeding eight-inches.
- D. Fill Compaction and Moisture Control: Obtain compaction with approved compaction equipment. Provide compaction equipment of proper size and in proper mechanical operating condition. All fill material shall be moisture conditioned to within two percent of optimum moisture content.
  - 1. Unpaved Areas: Compact each lift to 90 percent maximum dry density. Density test method: ASTM D 698.
  - 2. Paved Areas: Compact each lift to 95 percent maximum dry density, compact the top 18" to 100% maximum dry density. Density test method: ASTM D 698.
- E. Control moisture during placement and compaction operations. Remove and replace or scarify and aerate excessively moist material until required moisture content is obtained. Moisten excessively dry material by applying measured amounts of water uniformly to fill material until required moisture content is obtained.

3.9 EARTH BACKFILL

- A. General: Backfill excavations as promptly as work permits, but not until completion of inspection, testing and approval by the Soils Engineer.
- B. Placement and Compaction: Do not place backfill on frozen or muddy subgrades.
  - 1. Unpaved Areas: Place backfill material in loose lifts not exceeding eight inches. Compact each lift to 90 percent maximum dry density. Density test method: ASTM D 698.
  - 2. Paved Areas: Place backfill material in loose lifts not exceeding eight inches. Compact each lift to 98 percent maximum dry density, compact the top 18" to 100% maximum dry density. Density test method: ASTM D 698.
  - 3. All material to be moisture conditioned to within two percent of optimum moisture content.

## 3.10 GRADING

- A. General: Grade unpaved and paved areas to smooth and uniform surfaces and to prevent ponding of surface water.
  - 1. Unpaved Areas: Areas to receive topsoil shall be graded to allow for installation of minimum 6 inches of topsoil. Refer to Section 32 93 05 "Topsoiling, Seeding and Sodding". Grade slopes exceeding four feet horizontal to one foot vertical, to smooth and uniformly rounded surfaces.
  - 2. Paved Areas: Grade paved area subgrades to the lines, elevations and sections indicated or specified.

## 3.11 MAINTENANCE

- A. Maintain all paved access roads in a clean and dust free condition during earthwork or subsequent construction operations. Clean trucks and equipment, removing mud and debris, prior to entering project site access roads and public right-of-way.
- B. Maintain completed areas of project site free of trash and debris. Scarify, regrade and recompact subgrades damaged or disturbed by adverse weather, soil erosion, settlement and subsequent construction operations.

## 3.12 TESTING

- A. The following tests will be conducted.
  - 1. Laboratory Density Tests:
    - a. Test method: As specified.
    - b. Test interval: One test per each 15,000 s.f., or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines, and 1 per each 5,000 s.f., etc, for areas done by hand-operated machines.
  - 2. 2. In-place Field Density Tests:
    - a. Test method: ASTM D 1556-82 or D 2167.
    - b. Density required: As specified.
    - c. Test Interval: One test per 2,000 s.f., or fraction thereof, of compacted subgrade, or of each lift of fill or backfill compacted by other than hand-operated machines, and 1 per 1000 s.f., etc, for each lift of fill or backfill compacted by hand-operated machines.

B. Correct work not conforming to specified densities as directed by the Soils Engineer, at no increase to the Contract Sum.

## SECTION 31 20 05 - BUILDING EARTHWORK

### PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1, specification sections, apply to work of this section.
- 1.2 DESCRIPTION OF WORK
  - A. This section specifies materials, equipment and work required to perform building earthwork operations.
- 1.3 TESTING AND INSPECTIONS
  - A. Refer to Section 31 20 00 "Earthmoving".
  - B. All earthwork procedures shall be performed in the presence of the Soils Engineer. Give adequate (24 hours) notice when Soils Engineer's services are required. The Soils Engineer's duties will include, but not be limited to the following:
    - 1. Observation, testing, and approval of subgrade for footings before placement of concrete.
    - 2. Observation and approval of floor subgrade and fill placement before placement of underfloor granular base.
    - 3. Testing of proposed import fill material and verification of correlation of the import material to laboratory test samples. All test results shall be forwarded to the seeding and sodding contractor.
    - 4. Verification of removal of sediment from sediment control basins and testing of subgrade in basins prior to fill placement.

## 1.4 RELATED WORK

A. Refer to Section 31 10 00 "Clearing", Section 31 20 00 "Earthmoving".

## 1.5 CODES

- A. Refer to Section 31 20 00 "Earthmoving".
- 1.6 STANDARDS
  - A. Refer to Section 31 20 00 "Earthmoving".

## 1.7 SUBMITTALS

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Product Samples: Submit samples of the borrow material and structural fill material to the Owners' Testing Agency. Sample size to be fifty pounds. Number of samples to be

determined by the Owners' Testing Agency. The Contractor is required to get signed transmittals from the Owners' Testing Agency documenting delivery of samples to be submitted to the Construction Manager for Project Record.

## 1.8 DEFINITIONS

- A. Refer to Section 31 20 00 "Earthmoving".
- 1.9 PROJECT CONDITIONS
  - A. Refer to Section 31 20 00 "Earthmoving".
- 1.10 CONSTRUCTION SURVEYS
  - A. General: Retain the services of a locally registered land surveyor or professional engineer to provide horizontal and vertical alignment stakes required to perform building earthwork operations to subgrade elevations indicated or specified, and horizontal and vertical alignment stakes required to construct footings and foundations.
  - B. Earthwork Balance Conditions: Refer to Section 31 20 00 "Earthmoving".

## PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. Provide aggregate manufactured and of primary raw materials extracted or recovered within 500 mile radius of Project Site.
- B. Fill Material: ASTM D 2487, Unified Soils Classification ML or more granular. Liquid limit not to exceed forty (40). Plasticity Index not to exceed twelve (12). Maximum particle size to be 2-1/2 inches. Free of debris, organic materials, waste materials and frozen materials. Obtain and transport fill materials from project site or borrow areas at no increase to contract sum.
- C. Samples: Submit fill material samples for testing and approval to the Soils Engineer. Do not place fill until written approval is obtained. Sample approval will not relieve the contractor of the responsibility to have material placed conform to approved samples.
- D. Porous Fill: ASTM C 33 Coarse Aggregate, size number 467 (1-1/2 inch to No. 4), blast furnace slag prohibited.
  1. Size to be AASHTO M 43, size 57.
- E. Backfill Material: Refer to Section 31 20 00 "Earthmoving".

## PART 3 - EXECUTION

## 3.1 GENERAL

A. Coordinate building earthwork activities with the application of termite treatment. Refer to Section 31 31 16 "Termite Control".

### 3.2 PROTECTION AND RESTORATION

A. Refer to Section 31 20 00 "Earthmoving" and as noted. Provide support systems (e.g. sheeting, shoring, sheet piling, cribbing, etc.) at no increase to contract sum. Protect footing, foundation and slab subgrades, with insulating materials, to prevent frost penetration. Restore subgrades damaged from the lack of protection. Restoration work as directed by the Soils Engineer.

#### 3.3 DEWATERING

A. Refer to Section 31 20 00 "Earthmoving" and as noted. Perform building earthwork operations to prevent water accumulations detrimental to stability of footing and foundation subgrades.

## 3.4 EXCAVATION

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Foundation Excavation: Excavate to footing and foundation elevations indicated or specified. Extend excavations horizontally beyond footings and foundations to permit formwork placement and removal, support system placement and removal, foundation drainage system installation, building utility installations, waterproofing and inspection. Do not place concrete until completion of inspections, testing and approval by the Soils Engineer. Trim and shape excavations by manual methods, prior to concrete placement.
- C. Slab Excavation: Excavate to slab subgrade elevations indicated or specified. Excavate slab subgrades to smooth and even surfaces, free of voids and depressions. Prepare exposed subgrades as specified for paved areas, Section 31 20 00 "Earthmoving". Do not place concrete or porous fill until completion of inspection, testing and approval by the Soils Engineer. Inspection, testing and approval of subgrade shall be performed immediately prior to placement of porous fill and concrete.
- D. Below Slab Utility Excavation: Refer to Section 33 10 00 "Utility Standards" and as noted.
   1. Trench width below and 12 inches above top of utility not to exceed 12-inch clearance on
  - each side of utility.

## 3.5 OVER-EXCAVATION

A. Refer to Section 31 20 00 "Earthmoving" except as noted. Correct over-excavated areas as directed by the Soils Engineer or Owner's Representative.

#### 3.6 UNSUITABLE EARTH

- A. Refer to Section 31 20 00 "Earthmoving" except as noted. The Soils Engineer shall determine the least costly restoration method.
  - 1. Restore excavated areas by lowering footings and foundations to bottom of excavated area.
  - 2. Restore excavated area by backfilling with approved compacted fill material to design subgrade elevations.
  - 3. Payment for unsuitable earth removal and associated restoration operations will be by Change Order.

#### 3.7 EXCAVATED MATERIAL STORAGE

A. Refer to Section 31 20 00 "Earthmoving".

## 3.8 FILL

- A. Refer to Section 31 20 00 "Earthmoving", except as noted.
- B. Earth Fill: Prepare exposed subgrades as specified for paved areas, Section 31 20 00 "Earthmoving". Place fill material in loose lifts not exceeding eight inches and at moisture content within plus or minus two percentage points of optimum moisture content, and compact to 98 percent maximum dry density. Top 18 inches below foundations and slabs shall be compacted to 100 percent maximum dry density. Density test method: ASTM D 698.
  - 1. Compacted fill material shall extend at least ten feet beyond building lines for lateral support.
  - 2. Do not place concrete or porous fill until completion of inspection, testing and approval by the Soils Engineer. Inspection, testing and approval of subgrade shall be performed immediately prior to placement of porous fill and concrete.
- C. Porous Fill: Upon approval of prepared subgrade, place porous fill in uniform lifts and compact to 70 percent relative density.

## 3.9 BACKFILL

- A. Refer to Section 31 20 00 "Earthmoving". Place and compact backfill as specified for fill, except as noted.
- B. Backfill excavations as promptly as work permits, but not until completion of formwork removal, foundation drainage system installation, building utility installations, waterproofing, termite treatment, trash and debris removal, support system removal, temporary and/or permanent wall bracing installation, and inspection and approval by the Soils Engineer.
- C. Exercise care in the placement of backfill material adjacent to structure. Place backfill evenly and in a manner to prevent wedging action against the structure. Place backfill uniformly around the structure in lifts of equal elevation. Correct damage from improper backfilling operations, as directed by the Soils Engineer or Owner's Representative, at no increase to the Contract Sum.

D. Backfill placement operations to be tested and approved by the Soils Engineer.

#### 3.10 TESTING

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Foundation Subgrade Testing: For each stratum of soil, on which foundations will be placed, conduct one test to verify required design bearing capacities. Conduct a minimum of one test beneath each wall. Subsequent verification and approval of each foundation subgrade may be based on a visual comparison of each subgrade with related tested strata. Additional testing shall be conducted as required by the Soils Engineer.

#### 3.11 MAINTENANCE

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Tests, inspections, and approvals specified will be conducted in accordance with applicable Division One Sections regarding "Testing Services".

## **SECTION 31 31 16 - TERMITE CONTROL**

## PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1, specification sections, apply to work of this section.

#### 1.2 RELATED WORK

A. Refer to Section 31 20 00"Earthmoving", and Division 3 "Concrete".

## 1.3 DESCRIPTION OF WORK

A. This section specifies application of Termite Control soil treatment prior to placement of concrete floor slabs, foundation walls or grade beams.

#### 1.4 QUALITY ASSURANCE

A. Applicator's Qualifications: Applicators shall be registered or licensed where required by State or City jurisdictions.

### 1.5 WARRANTY

- A. On final acceptance, furnish the Owner's Representative with a written guarantee, executed by the Applicator and the Contractor, stating application was made in accordance with this specification, and certifying that the applied soil termiticide treatment will prevent infestation of subterranean termites.
- B. Guarantee effectiveness of treatment for not less than five years.
- C. Guarantee to correct damage caused by termite infestations in treated areas, within the fiveyear guarantee period. If subterranean termite activity is discovered during the guarantee period, the Contractor will re-treat the soil and repair or replace damage caused by the termite infestation.

#### 1.6 STANDARDS

- A. United States Department of Agriculture Federal Insecticide, Fungicide and Rodenticide Act.
- B. The formulation of all soil poisons, insecticides, fungicides, etc. shall be registered under the Act and shall be registered with the appropriate agency of the State of Maryland.

## 1.7 SUBMITTALS

- A. Submit manufacturer's written mixing and application instructions.
- B. Submit typewritten detailed description of termite treatment program to, and obtain approval from, the local jurisdiction prior to implementation.

C. Submit evidence of compliance with Federal and State regulations.

## 1.8 PROJECT CONDITIONS

A. Protect occupied portions of existing structures to remain from fumes and vapors from application of the termite treatment.

### PART 2 - PRODUCTS

#### 2.1 SOIL TREATMENT SOLUTIONS

- A. General: Use an emulsible, concentrated termiticide that dilutes with water, specially formulated to prevent termite infestation. Fuel oil will not be permitted as a dilutent. Use only soil treatment solutions that are not harmful to plants.
- B. Provide a solution consisting one of the following chemical elements:
  - Premise, Bayer.
  - 1. Permathrin:
    - a. Dragnet.
  - 2. Cypermethrine:
    - a. Prevail FT, FMC Corp.
    - b. Dermon, ICI Americas, Inc.
  - 3. Fenvalerate:
    - a. Gold Coast Tribute, Du Pont
  - 4. Isofenphose:
    - a. Pryfon, Mobay Corp.
- C. Mixes: Dilute with water to concentration level recommended by the manufacturer. Follow manufacturer's written mixing instructions.

## PART 3 - EXECUTION

## 3.1 INSPECTION:

- A. Verify that soil is in friable condition with moisture content low enough to permit absorption of toxicant solution. Remove any foreign matter which could decrease effectiveness of treatment.
- B. Do not apply soil treatment until excavating, filling and grading operations are complete, except as otherwise required.
- C. Do not apply soil treatment to frozen or excessively wet soils or during inclement weather.

## 3.2 APPLICATION

- A. Apply soil treatment to areas beneath concrete floor slabs on grade or fill, suspended slab structures, at hollow masonry foundations and grade beams and along interior and exterior sides of foundation walls and grade beams.
- B. Apply soil treatment at expansion joints, control joints and all areas where slabs will be penetrated.
- C. Do not apply soil treatment solution until excavating.

## 3.3 RATE OF APPLICATION

- A. Surface Preparation: Remove foreign matter which could decrease effectiveness of treatment on areas to be treated. Loosen, rake and level soil to be treated, except previously compacted areas under slabs and foundations. Toxicants may be applied before placement of compacted fill under slabs, if recommended by toxicant manufacturer.
- B. Application Rates: Apply soil treatment solution as follows:
- C. Under slab-on-grade structures, treat soil before concrete slabs are placed, using the following rates of application:
  - 1. Apply 4 gallons of chemical solution per 10 linear feet to soil in critical area under slab, including entire inside perimeter inside of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating slab, and around interior column footers.
  - 2. Apply one gallon of chemical solution per 10 square feet as an overall treatment under slab and attached slab areas where fill is soil or unwashed gravel. Apply one and one half gallons of chemical solution per 10 square feet to areas where fill is washed gravel or other coarse absorbent material.
  - 3. Apply 4 gallons of chemical solution per 10 linear feet of trench, for each foot of depth from grade to footing, along outside edge of building. Dig a trench six inches to eight inches along outside of foundation to a depth of not less than 12 inches. Punch holes to top of footing at not more than 12 inches on center and apply chemical solution. Mix chemical solution with the soil as it is being replaced in trench.
- D. Under crawl-space and basement structures, treat soil along exterior and interior walls of foundations with shallow footings as specified above for exterior of slab-on-grade structures.
- E. At hollow masonry foundations or grade beams, treat voids at rate of 2 gallons per 10 linear feet, poured directly into the hollow spaces.
- F. At expansion joints, control joints, and areas where slabs will be penetrated, apply at a rate of 4 gallons per 10 linear feet of penetration.
- G. Post signs in areas of application to warn workers that soil termiticide treatment has been applied. Remove signs when areas are covered by other construction.

H. Re-apply soil treatment solution to areas disturbed by subsequent excavation, landscape grading, or other construction activities following application.

## **SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION**

## PART 1 – GENERAL

## 1.1 SUMMARY

A. Work of this section includes sheeting and shoring and bracing.

## **1.2 RELATED SECTIONS**

- A. Section 31 10 00: Clearing
- B. Section 31 20 00: Earthmoving

## **1.3 SYSTEM DESCRIPTION DESIGN REQUIREMENTS**

- A. Shoring systems shall be designed to safely and adequately prevent collapse of adjacent materials and permit construction of Work to arrangement shown on Contract Documents.
- B. Secure approvals, including those of local governmental agencies having jurisdiction.
- C. Analyze site conditions. Make supplemental investigations as needed for proper design of shoring.

## 1.4 QUALITY ASSURANCE SUBMITTALS FOR DESIGN DATA

- A. Prepare and submit design drawings and calculations showing analysis of work to be performed, including horizontal support for shoring.
- B. Drawings shall include methods, equipment and work procedures.

## 1.5 QUALITY ASSURANCE

- A. Qualifications
  - 1. Bracing and shoring drawings shall be prepared by a registered professional engineer, licensed to practice in the State of Maryland. Drawings and calculations shall bear seal of Professional Engineer registered in the State of Maryland.
  - 2. Personnel performing installation shall be trained or qualified in techniques and procedures of shoring installation with a minimum of three (3) years successful experience in such installation.
  - 3. Installation shall be performed under supervision of a Professional Engineer registered in the State of Maryland, experienced in this type of work.
- B. Regulatory Requirements: Conform to requirements of Occupational Safety and Health Administration (OSHA) as well as measures accepted as standards of industry.
- C. Certifications: Upon completion of shoring, submit a letter signed and sealed by design engineer stating that, to best of his or her knowledge, systems were constructed in compliance with design

drawings and calculations.

#### 1.6 LEED Submittals: Comply with Section 018113.

- A. MR Credit 3: BPDO Sourcing of Raw Materials
  - 1. For recycled content steel: Documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include material cost value.
  - 2. For regionally sourced steel: Documentation indicating locations of recovery, manufacture, purchase of recycled raw materials.

#### PART 2 – PRODUCTS

## 2.1 MATERIALS

- B. Materials shall be selected and furnished to perform in compliance with design criteria.
- C. Structural Steel Shapes and Plates: ASTM A 36 or ASTM A 572. Steel shall be of American manufacturer, new and free from defects in strength, durability, appearance and function.
  - 1. Recycled Content: Provide steel with minimum 90 percent total recycled content, including at least 60 percent post-consumer recycled content.

## PART 3 – EXECUTION

#### 3.1 EXAMINATION

A. Site Verification of Conditions: Prior to commencing work of this Section, check and verify governing dimensions and elevations, including field measurements of existing or adjoining work on which this work is dependent to assure proper fit and clearances between new and existing structures.

#### 3.2 PREPARATION

#### A. Protection

- 3. Protect and support water, sewer, gas, and other pipes and electrical conduits encountered and immediately notify persons, companies or governmental agencies, granting them ample opportunity to take such additional precautions as they may deem necessary.
- 4. Cut and cap street connections encountered in excavating along curb lines in compliance with local jurisdiction requirements. Mark locations of capped utilities so they may be subsequently located and reconnected as needed.
- 5. Damage to adjacent properties, streets, sidewalks and utilities caused by work under this Section shall be repaired, restored to original condition, or replaced at no additional expense to Owner.

## B. Coordination

- 1. Prepare a photographic or video survey of existing crack conditions in adjacent facilities and other conditions of structures prior to commencing work.
- 2. Maintain free flow of pedestrian and vehicular traffic to and from adjacent properties at levels existing prior to start of work and as described in Section 31 10 00 "Clearing".
- 3. Interior bracing shall be arranged to offer no interference with formwork for new

construction.

- 4. Provide sufficient quantity of materials on hand at all times for protection of Work and for use in event of emergency.
- 5. Setting of formwork, reinforcing and placement of concrete shall be in compliance with requirements described in other related Sections of this Project Manual.
- 6. Provide pumps and other equipment as necessary to dewater excavations for shoring operations.

### C. Sheeting

- 1. Provide sheeting of proper lengths and section needed, and anchor or brace to resist earth and hydrostatic pressures and superimposed loads from adjacent structures and/or construction equipment.
- 2. Install sheeting plumb and true, to lines and locations as indicated on design submittal drawings. Sheeting shall be used to form concrete walls and shall be located and driven to ensure that no part of sheeting is within outline of permanent construction.
- 3. Sheeting retaining earth on which support and stability of existing structures is dependent shall be left in place at completion of Work.

## D. Shoring

- 1. Locate shoring at distances away from new construction sufficient to allow working room and observation of construction.
- 2. Shoring shall be set clear of permanent footings, walls and other structural features.
- 3. Shoring shall be installed to retain earth under surcharges, including such loads as weight of construction materials and equipment, vibration, snow, rainwater, water absorption by soils, and temporary construction.
- 4. Extend shoring as high as necessary to allow for construction of foundation walls and for berming to divert water run-off. Depth of shoring shall be as deep as necessary to brace excavation to ultimate depth.
- 5. Shoring supporting formwork may not be left in place upon written approval by the Owner's Representative.

#### 3.3 RESTORATION

- A. Remove temporary protective installations upon completion of shoring operations.
- B. Repair damage to structures caused by shoring operations and restore surfaces to original or better condition.

## 3.4 CLEANING

A. Remove debris and excess earth resulting from shoring operations as it accumulates. Do not store debris on site or permit debris to be scattered over site.

## SECTION 32 12 16 - HOT-MIXED ASPHALT PAVEMENT

### PART 1 - GENERAL

#### **1.1 RELATED DOCUMENTS**

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1, Specification Sections, apply to work in this section.

## **1.2 DESCRIPTION OF WORK**

A. This section specifies materials and work required to construct new asphalt pavement, asphalt curbing, asphalt walks and overlay existing asphalt pavement.

#### 1.3 RELATED WORK

 A. Refer to Section 31 10 00 "Clearing", Section 31 20 00 "Earthmoving", and Section 32 13 15 "Concrete Curbing".

### **1.4 STANDARDS**

- A. Maryland Department of Transportation State Highway Administration, current "Standard Specifications for Construction and Materials".
- B. Frederick County Department of Transportation current "Design Standards".

#### 1.5 SUBMITTALS

## A. Products:

- 1. Submit asphalt plant mix formula, for each course specified. Mix formula to include percentage of aggregate passing each sieve size, percentage of bituminous material added to aggregate and mix temperature.
- 2. Submit certificates, signed by producer or manufacturer and contractor, stating that base course material and asphalt comply with this specification.
- 3. Submit results of testing specified for review by the Architect, Owner's Representative and required jurisdictional inspectors.
- 4. For products having recycled content, documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.
- 5. For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

## 1.6 PRODUCT DELIVERY AND STORAGE

A. Asphalt mixtures: Delivery temperature not to exceed 25 degrees Fahrenheit below plant mix temperature.

## **1.7 PROJECT CONDITIONS**

- A. Existing Asphalt Pavements: Verify existing pavement conditions (e.g. deteriorated surface, joints, etc.) during prebid inspection.
- B. Traffic: Maintain vehicular traffic during pavement construction operations.
- C. Limitations: Do not proceed with pavement construction until underground utility construction is complete. Do not proceed with asphalt placement operations until adjacent or adjoining Portland cement concrete curb construction is complete. Do not place bituminous materials when ambient air temperature is below 40 degrees Fahrenheit or air temperature has been below 35 degrees Fahrenheit for 12 or more consecutive hours. Do not place materials from 15 November to 1 March without written authorization from the Architect.
- D. Construction Surveys: Retain the services of a locally registered land surveyor or professional engineer to provide combined horizontal and vertical alignment stakes for road base construction.
  - 1. Paved area base alignment stake horizontal interval: 50 foot maximum stations at centerline and both edges to finished base elevations.

## PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. General: Provide products manufactured and of raw materials extracted/recovered within a 100-mile radius of the Project Site.
- B. Subbase Course: SHA Graded Aggregate Subbase: Section 901.01.
- C. Asphalt Base (Binder) Course: Shall be Bituminous Concrete intermediate band, SuperPave, 19.0mm PG 64-22 Band per Division 5000 and Section 904A of the Reference Specification. Compacted thickness as noted on the plans.
- D. Tack Coat: SHA cut-back asphalt: Section 904.04, M 81 or M 82.
- E. Overlay Binder Coat: Asphalt cement: AASHTO M 20, penetration grade 80-100.
- F. Overlay Protective Membrane: "Petromat" protective membrane manufactured by Phillips Fiber Corporation, a subsidiary of Phillips Petroleum Company, Greenville, South Carolina.

- 1. Option: "AmoPave" protective membrane manufactured by Amoco Fabrics Company, Atlanta, Georgia.
- G. Overlay Protective Membrane Strips: "PavePrep" fiber reinforced mastic strips, manufactured by The PavePrep Corporation, Westfield, New Jersey.
- H. Asphalt Surface Course: Shall be Bituminous Concrete surface band, SuperPave, 9.5mm
   PG 64-22 Band per Division 5000 and Section 904A of the Reference Specification.
   Compacted thickness as noted on the plans.
- Asphalt Surface Course for Athletic Courts and Paved Play Areas: Shall be Bituminous Concrete surface band, SuperPave, 4.75mm PG 64-22 Band per Division 5000 and Section 904A of the Reference Specification. Compacted thickness as noted on the plans.
- J. Joint Sealant: MDOT-SHA Section 911.01.
- K. Provide minimum 25 percent recycled asphalt paving (RAP).

## PART 3 - EXECUTION

## 3.1 PROTECTION AND RESTORATION

A. Asphalt Pavement: Protect improvements and facilities during tack coat and overlay binder coat applications to prevent overspray damage. Protect completed surface from damage. Do not permit heavy equipment or rollers on completed surface. Do not permit vehicular traffic on surface for 24 hours after completion. Restore damaged pavement as directed by the Owner's Representative or the Architect, at no increase to contract sum.

## 3.2 SUBGRADE PREPARATION

- A. Paved Areas: Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Verify subgrade compaction and elevations and correct discrepancies before proceeding with base construction. Verify utility casting elevations and reset or adjust to meet flush with finished pavement surface. Do not place the base material/subbase material on frozen or muddy subgrade.

## 3.3 SUBBASE COURSE

A. Place subbase course material on prepared subgrade in one uniform layer to depth required to produce compacted thickness indicated. Shape material, to sections and elevations indicated with blade grader and compact with pneumatic tired rollers to 98 percent maximum dry density. Control moisture content of the base course material to within 2 percent of optimum during compaction operations. Compaction Standard: ASTM D 698. Proof roll subbase course with 10 ton tandem steel wheel roller and correct irregularities.

### 3.4 ASPHALT BASE COURSE

- A. Subbase Course Surface Preparation: Apply tack coat material to previously placed asphalt base course, existing pavement, curbing, utility castings and any structure abutting or projecting into paved area.
- B. Base Course Placement: Place asphalt in layers not exceeding four inches in compacted depth to total depth required to produce compacted thickness indicated. Place material with mechanical self-powered pavers capable of maintaining required line and grade. Place material by approved manual methods in areas inaccessible to self-powered pavers. The temperature of the material shall be not less than 225 degrees Fahrenheit at the time of placement.
- C. Base Course Compaction: Compaction operations shall begin immediately following placement of the base course material, and shall consist of breakdown, intermediate and finish rolling. Material shall be compacted to in-place density of 92 to 97 percent of theoretical maximum density. In-place compaction shall be completed before the material cools below 185 degrees Fahrenheit. Use self-powered tandem steel wheel rollers. Use power driven trench rollers in areas inaccessible to self-powered equipment. Begin rolling longitudinally at low side or edge and proceed toward high side or crown. Overlap successive roller trips one half-roller width. Do not terminate alternate roller trips at the same location. Continue finish rolling until 98 percent to 102 percent theoretical maximum density is obtained and all roller marks are eliminated. Density test method: AASHTO T 230.

## 3.5 ASPHALT SURFACE COURSE AND OVERLAY

- A. General: Provide overlay protective membrane treatment where indicated. Provide overlay protective membrane strips over all long, running cracks or pavement joints except in areas where overlay protective membrane is already indicated.
- B. Asphalt Base Course Surface Preparation: Remove loose material from surface before applying tack coat. Apply tack coat material uniformly to surface at a rate of 0.10 gallon per square yard. Allow tack coat to cure as long as required to properly set but not less than 12 hours.
- C. Existing Asphalt Pavement Preparation: Clean and dry pavement, with compressed air, removing debris, dust, foreign materials and moisture.
  - Obtain pavement preparation approval, from the Architect prior to overlay binder coat application. Apply overlay binder coat material uniformly to prepared asphalt surface. Apply at a rate of 0.25 gallon per square yard. For long running cracks or joints in existing pavement surface where overlay protective membrane strips will be used, apply overlay binder coat material to a width of approximately two feet so as to span existing cracks or joints. Adjust application rate, based on existing pavement relative porosity, at

no increase to contract sum. Apply overlay binder coat material at 300 degrees Fahrenheit minimum to 350 degrees Fahrenheit maximum.

- 2. Lay down overlay protective membrane, on cured overlay binder coat, in accordance with manufacturer's installation instructions and as noted. Transverse joint overlap to be 12 inches, "shingled" in the direction of paving to prevent edge pick-up by the pavers. Longitudinal joint overlap to be six inches. Cut and piece membrane to fit irregular shaped areas (e.g. access road intersections, curb returns, etc.). Obtain pavement preparation approval from the Owner's Representative or the Architect prior to tack coat application.
- 3. Lay down overlay protective membrane strips on cured overlay binder coat, in accordance with manufacturer's installation instructions and as noted. Unroll overlay protective membrane strips, aligned with pavement joints, and seat in tacky overlay binder coat material by brooming, so as to span existing pavement joints. Blot excess overlay binder coat materials on the edges of the membrane strips with sand blanket. Cut and piece membrane to fit irregular shaped areas (e.g. access road intersections, curb returns, etc.). Obtain pavement preparation approval from the Owner's Representative or the Architect prior to tack coat application.
- 4. Apply tack coat material uniformly to prepared asphalt surface. Apply at rate of minimum of 0.05 gallons per square yard and a maximum of 0.15 gallons per square yard. Tack coat to cure as long as required to properly set, but not less than 12 hours.
- 5. Prepare existing asphalt pavement, as indicated and specified, at no increase to contract sum.
- D. Surface Course and Overlay Placement: Place asphalt, in one uniform layer, to depth required to produce the compacted thickness indicated. Place with mechanical self-powered pavers capable of maintaining required line and grade. Place and spread asphalt by approved manual methods in areas inaccessible to self-powered pavers. The temperature of the material shall be not less than 225 degrees Fahrenheit at the time of placement.
- E. Surface Course and Overlay Compaction: Compaction operations shall begin immediately following placement of the surface course material, and shall consist of joint, breakdown, intermediate and finish rolling. In-place compaction shall be completed before the material cools below 185 degrees Fahrenheit. Use power driven trench rollers in areas inaccessible to self-powered rollers. Begin rolling longitudinally at low side or edge and proceed toward high side or crown. Overlap successive roller trips, one-half roller width. Do not terminate alternate trips at same point. Continue finish rolling until 98 percent to 102 percent theoretical maximum density is obtained and all roller marks are eliminated. Density test method: AASHTO T 230.

## 3.6 JOINT SEALING

A. Completely seal and fill joints along existing and new pavement and curbing interface with joint sealant.

## 3.7 TESTING

- A. General: Correct work not conforming to specified tolerances as directed by the Owner's Representative or the Architect, at no increase to the contract sum.
- B. Thickness Tests: Conduct subbase, base and surface course thickness tests and provide test area restoration upon completion. Tolerance not less than one-half inch from compacted thickness indicated. Test locations are random and to be determined by the Owner's Representative or the Architect. Regardless of paved area size, at least one test shall be performed for each newly paved area.
- C. Smoothness Tests: Conduct surface course smoothness tests. Tolerance not to exceed oneeighth inch between any two surface contacts on 10-foot straightedge. Test locations are random and to be determined by the Owner's Representative or the Architect. Regardless of paved area size, at least one test shall be performed for each newly paved area.
- D. Laboratory Density Tests: Conduct subgrade, subbase and base course laboratory density tests. Density testing shall be performed by individuals certified to perform asphalt testing. Test method: ASTM D 1557. Test interval to be determined by the Owner's Representative or the Architect, but no less than one test for each newly paved area and/or one test per 1000 feet of roadway shall be performed.
  - 1. Provide test area restoration.
- E. Field Density Tests: Conduct subgrade, subbase and base course in-place field density tests. Density testing shall be performed by individuals certified to perform asphalt testing. Test method: ASTM D 1556 or D 2167. Test locations are random and to be determined by the Owner's Representative or the Architect, but no less than one test for each newly paved area and/or one test per 1000 feet of roadway shall be performed.
  - 1. Provide test area restoration.

## 3.8 CLEANING

A. Clean improvements and facilities damaged by tack coat overspray as directed by the Owner's Representative or the Architect.
# **SECTION 32 12 20 - ROAD AND PARKING ACCESSORIES**

# PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, Specification Sections, apply to work in this section.

### **1.2 DESCRIPTION OF WORK**

A. This section specifies materials and work required to apply, install and construct miscellaneous road and parking accessories.

# **1.3 RELATED WORK**

A. Refer to Section 31 20 00 "Earthmoving", and Section 32 13 15 "Concrete Curbing".

# **1.4 STANDARDS**

- A. Maryland Department of Transportation State Highway Administration's current "Standard Specifications for Construction Materials".
- B. "Manual on uniform Traffic Control Devices for Streets and Highways" ANSI D6.1-1971.

#### 1.5 SUBMITTALS

- A. Products:
  - 1. Submit manufacturer's specifications and application instructions for pavement marking paint.
  - 2. Submit manufacturer's descriptive literature for road and parking area signs.

#### 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver paint to project site in original unopened containers bearing manufacturer's label.
- B. Store paint in tightly covered containers.

#### **1.7 PROJECT CONDITIONS**

- A. Maintain vehicular and pedestrian traffic during pavement marking operations. Do not apply paint when ambient air temperature is below 50 degrees Fahrenheit, relative humidity exceeds 85%, wind exceeds 20 miles per hour or pavement surface temperature is below 50 degrees Fahrenheit.
- B. Contractor shall notify Fire Marshal within 48 hours of completion of curbing and pavement construction to schedule site inspection for purposes of designating locations of curb marking. Curbs at fire lanes shall be painted yellow, unless noted otherwise by the Fire Marshal.

- C. Curbs and line stripes at handicapped parking spaces shall be painted yellow.
- D. All other on-site striping shall be white.

# PART 2 - PRODUCTS

# 2.1 MATERIALS

- A. Pavement Marking: AASHTO M 248, type I, non-reflective paint, colors as noted. Materials used in the Public Right-of-Way shall be Type B, Class I, Thermoplastic alkyd. Materials used in the Public Right-of-Way shall be approved by Frederick County Department of Transportation, Traffic Engineering prior to installation. Colors shall be:
  - 1. Standard Parking Spaces: White
  - 2. Bus Stacking Spaces: White
  - 3. Handicapped Parking Spaces Yellow
  - 4. Traffic Lanes: Yellow
- B. Curb Marking: AASHTO M 248, type I, reflective yellow paint.
- C. Road and Parking Area Signs:
  - 1. Handicapped Parking Area and Fire Lane Signs: In accordance with Frederick County Department of Transportation standards, and the MUTCD.
  - 2. Stop Signs shall be 30" by 30" signs.
- D. Traffic Control Signs:
  - 1. Traffic control signs in accordance with Frederick County Department of Transportation's standards, the MUTCD, and as indicated.
- E. Sign Posts: Galvanized steel channel with 5/16 by two inch steel nuts and bolts and galvanized steel washers.

# PART 3 - EXECUTION

# 3.1 PAVEMENT MARKING

- A. Surface Preparation: Clean pavement surfaces, removing grease, oil, mud and foreign materials.
- B. Preparation for New Pavement Markings: Layout markings to dimensions and line widths indicated and specified. Bituminous concrete pavement to cool and set five calendar days prior to paint application. Do not apply marking materials to wet or damp pavement surfaces. Do not apply marking materials until pavement marking removal paint has set and hardened. Surfaces to set an additional eight hours after appearing dry.
- C. Application: Thermoplastic pavement marking materials shall be applied to the pavement at a minimum temperature of 400 degrees Fahrenheit. Apply paint to width and length of pavement marking lines indicated, and as noted. Apply paint with spray equipment and/or conventional traffic line striping equipment, and in accordance with paint manufacturer's recommendations, to produce markings parallel and with sharp line edges, uniform in cross section and with line widths as indicated or specified. Minimum application rate to be 100 feet per gallon.

- 1. Layout and apply paint for universal handicapped space symbols in accordance with standard practice and as directed by the Architect or the Owner's Representative.
- D. Protection and Restoration: Protect completed paint marking from damage. Do not permit vehicular or pedestrian traffic on completed marking until paint has set and hardened. Restore damaged paint marking as directed by the Architect.

# 3.2 CURB MARKING

- A. Locations:
  - 1. Fire Marshal will tour site after completion of curbing and pavement construction. During tour Fire Marshal will indicate locations where curb marking is to be applied. Contractor shall apply markings at no increase to contract sum.
- B. Application: Allow concrete curbing to cure 14 calendar days prior to paint application. Clean curb surfaces removing grease, oil, mud and foreign material. Do not apply paint to wet or damp curb surfaces. Apply paint to face and top of curbing by manual brush methods or with spray equipment.

# 3.3 ROAD AND PARKING AREA SIGNS

- A. Sign Locations: Locations of various sign types shall be as indicated on Construction Drawings and as directed by the Owner and the Architect. Contractor shall provide and install indicated and selected signs at no increase to Contract Sum.
- B. Post Installation: Excavate post footing to 12 inch diameter and 30 inch depth. Place and consolidate concrete in footing excavation. Install post and assembled sign in concrete plumb to 1/4 inch in 10 feet and 24 inch depth. Provide bracing to prevent movement. Slope concrete surface one inch with outside edges flush with finished grade and trowel to smooth finish. Contractor shall allow concrete footings to cure a minimum of 14 calendar days before removing bracing.

# SECTION 32 13 13 - CONCRETE PAVING

# PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, Specification Sections apply to work in this section.

## 1.2 DESCRIPTION OF WORK:

A. This section specifies materials and work required to construct Portland cement concrete walks.

# 1.3 RELATED WORK:

A. Refer to Section 31 20 00 "Earthmoving", and Section 32 13 15 "Concrete Curbing".

### 1.4 STANDARDS:

- A. Maryland Department of Transportation State Highway Administration's current "Standard Specifications for Construction and Materials".
- B. Frederick County, Department of Transportation's current "Design Standards".

### 1.5 SUBMITTALS:

- A. The contractor shall provide a sample of eight linear feet of typical concrete walk, with a control joint, for approval by the Owner's Representative. No additional concrete walk may be constructed until the sample is inspected and approved.
- B. For products having recycled content, documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.
- C. For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

#### 1.6 PROJECT CONDITIONS:

- A. Traffic: Maintain pedestrian traffic during walk construction operations.
- B. Limitations:
  - 1. Underground Utilities: Do not proceed with concrete construction until underground utility construction is complete.
  - 2. Curbing: Do not proceed with concrete walk construction until adjacent or adjoining curb construction is complete.
  - 3. Environmental: Refer to Section 33 10 00 "Utility Standards".

# PART 2 - PRODUCTS

# 2.1 MATERIALS:

- A. Recycled Content:
  - 1. Provide recycled concrete (RC-6) subbase and fill material, except under building slab.
  - 2. Provide minimum 25 percent recycled content in Portland Cement replacement with Engineer's approval.
  - 3. Provide steel bars with minimum 90 percent recycled content with at least 60 percent postconsumer.
- B. Provide aggregate and steel reinforcing bars manufactured and of primary raw materials extracted or recovered within 500 mile radius of Project Site.

B. Regional Materials; Provide concrete materials recovered and manufactured within 100 mile radius of Project Site.

- C. Gravel Base: ASTM C 33 coarse aggregate, size number 6 (1" to No. 4).
  1. Contractor's Option: MDOT-SHA Coarse Aggregate No. 57 Stone.
- D. Concrete: Class "A" Portland cement concrete, Section 33 10 00 "Utility Standards".
  - 1. Maximum 50% GGBF slag replacement for Portland cement, per MDOT-SHA Specification 902.06.05
- E. Joint Materials: Expansion and Isolation Joints: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.
- F. Forms: Steel or wood for straight or tangent walks. Non-rented wood materials shall be FSC-certified sustainably harvested.
- G. Curing Materials: Burlap Mats: AASHTO M182, Class 1.
- H. Miscellaneous Products:
  - 1. Form Release Compound: Non-staining, zero-VOC, 100% biodegradable made from plant-based oils and approved by the Architect.
  - 2. Cement Mortar: Section 33 10 00 "Utility Standards".

# PART 3 - EXECUTION

#### 3.1 PROTECTION AND RESTORATION:

A. Concrete: Protect completed concrete from damage. Restore damaged concrete as directed by the Owner's Representative or the Architect.

#### 3.2 SUBGRADE PREPARATION:

A. Paved Areas: Section 31 20 00 "Earthmoving" and as noted. Verify subgrade elevations and compaction and correct discrepancies before proceeding with construction. Verify utility casting elevations and reset or adjust to meet flush with finished concrete surface. Remove loose material from subgrade prior to gravel base placement.

# 3.3 GRAVEL BASE PLACEMENT:

A. Place and compact gravel base on prepared subgrade to depth indicated. Remove debris from surface of gravel base prior to placement of concrete. Do not place gravel base material on frozen or muddy subgrade.

# 3.4 FORMS:

A. Clean and coat forms with form release compound, prior to use. Install forms to lines, grades and elevations indicated or as specified. Brace forms to prevent movement during concrete placement.

# 3.5 EXPANSION JOINTS:

A. Install expansion joints at maximum 25-foot intervals or as indicated. Install expansion joints, adjacent to curbing, opposite curbing joints and as indicated. Place expansion joints perpendicular to concrete surface and with top edge 1/4 inch below concrete surface.

# 3.6 ISOLATION JOINTS:

A. Install isolation joints where concrete abuts buildings, existing walk sections, utility structures and concrete curb. Place isolation joints with top edge 1/4 inch below concrete surface.

# 3.7 CONTRACTION JOINTS (SCORE LINES):

A. Provide contraction joints at five-foot intervals or as indicated. Form contraction joints with 3/4 inch jointing tool.

# 3.8 CONCRETE PLACEMENT:

- A. Sample Approval: No concrete walks may be constructed until the sample section has been inspected and approved by the Owner's Representative.
- B. General: Place concrete in forms in one uniform layer. Consolidate concrete by tamping, spading or vibrating to prevent honeycombing. Place and consolidate concrete carefully to prevent dislocation of joint materials.

# 3.9 FINISHING:

- A. General: Draw a fine hair broom across concrete surface. Where longitudinal grade exceeds five percent, use a coarse texture finish by drawing a stiff bristle broom across concrete surface.
- B. Handicapped Ramps: Handicapped ramps shall have exposed aggregate (or other approved detectable) surface.

# 3.10 CURING:

A. Mat Method: Moisten mats thoroughly with water before placing on exposed concrete surfaces and overlap six inches. Cover mats with polyethylene sheeting and maintain mats in continuously moist condition for seven calendar days. Repair or replace damaged mats.

# 3.11 TESTING:

- A. General: Correct work not conforming to tolerances as directed by the Owner's Representative or the Architect, at no increase to the contract sum.
- B. Walk Horizontal Alignment Test: Tolerance not to exceed 1/2 inch between any two contacts on 10-foot straightedge, except along horizontal curves. Test locations random and determined by the Owner's Representative or the Architect. Test observation by the Owner's Representative or the Architect.
- C. Walk Surface Smoothness Test: Tolerance not to exceed 3/8 inch between any two surface contacts on 10-foot straightedge. Test locations random and determined by the Owner's Representative or the Architect. Test observation by the Owner's Representative or the Architect.

# SECTION 32 13 15 - CONCRETE CURBING

# PART 1- GENERAL

### 1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 and Specification Sections apply to work in this section.

## 1.2 DESCRIPTION OF WORK:

A. This section specifies materials and work required to construct Portland cement concrete curbing.

# 1.3 RELATED WORK:

A. Refer to Section 31 20 00 "Earthmoving", and Section 32 13 13 "Concrete Paving".

# 1.4 STANDARDS:

- A. Maryland Department of Transportation State Highway Administration's current "Standard Specifications for Construction and Materials".
- B. Frederick County, Department of Transportation's current "Design Standards".

### 1.5 SUBMITTALS:

- A. Submit cut sheets for construction of curb in the public right-of-way to and obtain approval from the governing jurisdiction and the Architect prior to curb construction.
- B. The contractor shall provide a sample of eight linear feet of typical concrete curb-and-gutter, with a control joint, for approval by the Owner's Representative. No additional concrete curbing may be constructed until the sample is inspected and approved.

# C. LEED Submittals

- 1. Product data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.
- 2. Product data for Credit MR 5: For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

# 1.6 PROJECT CONDITIONS:

A. Traffic: Maintain vehicular and pedestrian traffic during curb construction operations.

# B. Limitations:

1. Environmental: Refer to Section 33 10 00 "Utility Standards".

2. Underground Utilities: Refer to Section 32 13 13 "Concrete Paving".

# 1.7 CONSTRUCTION SURVEYS:

- A. Retain the services of a locally registered land surveyor or professional engineer to provide combined horizontal and vertical alignment stakes for curb construction within public right of way. Horizontal stake interval 25 feet maximum.
- B. Provide combined horizontal and vertical alignment stakes for project site curb construction. Horizontal stake interval 25 feet maximum.

# PART 2 - PRODUCTS

# 2.1 MATERIALS:

- B. Concrete: Class 'A' Portland cement concrete, Section 33 10 00 "Utility Standards"
- C. Joint Materials: Expansion and isolation joints: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.
- D. Forms: For straight or tangent curbing use steel or wood. For curved curbing use flexible spring steel or laminated wood.
- E. Curing Material: Refer to Section 32 13 13 "Concrete Paving".
- F. Stone Base: SHA GA-Subbase, as indicated.
- G. LEED Submittals
  - 1. Recycled Content: Provide minimum 25 percent recycled content in Portland cement replacement.
  - 2. 2. Regional Materials: Provide concrete materials recovered and manufactured within 100 mile radius of Project Site.

# PART 3 - EXECUTION

#### 3.1 PROTECTION AND RESTORATION:

A. Refer to Section 32 13 13 "Concrete Paving".

# 3.2 SUBGRADE PREPARATION:

A. Refer to Section 32 13 13 "Concrete Paving".

# 3.3 FORMS:

- A. Refer to Section 32 13 13 "Concrete Paving", and as noted.
- B. Form curbing to standards indicated and specified.

#### 3.4 EXPANSION JOINTS:

- A. Refer to Section 32 13 13 "Concrete Paving" and as noted.
- B. Install expansion joints at maximum 30-foot intervals or as indicated. Place expansion joints perpendicular to surface and curbing face. Place combination curb and gutter expansion joints, with top edge one-half inch below gutter surface.
- 3.5 ISOLATION JOINTS:
  - A. Refer to Section 32 13 13 "Concrete Paving".
- 3.6 CONTRACTION JOINTS:
  - A. Refer to Section 32 13 13 "Concrete Paving" and as noted.
  - B. Provide contraction joints, perpendicular to surface and face of curbing, at 10 foot intervals.
     Place contraction joints at all points where curved and tangent sections of curbing meet.
     Place contraction joints with removable form spreader places. Contractor's option: Score or saw joints to 1-1/4 inch depth.
- 3.7 CONCRETE PLACEMENT:
  - A. Refer to Section 32 13 13 "Concrete Paving".
- 3.8 FINISHING:
  - A. Strike off top surfaces of curbing to top of forms and to smooth and uniform texture. Strip curb face forms when concrete takes initial set. Trowel curb face to smooth and uniform texture. Finish top surfaces and curb face to fine texture by drawing a soft bristle brush longitudinally along curb. Finish edges of curbing with edging tool having a radius as indicated. Maintain forms, except curb face forms, in place 12 hours after concrete placement. Correct defects (e.g. holes, honeycomb areas, broken edges, etc.) upon removal of remaining forms, with cement mortar. Finish contraction joints with 1/4-inch radius edging tool. Finish curbing joints to clean and true edges. Maintain curbing surfaces moist during finishing operations.
  - B. Curing: Refer to Section 32 13 13 "Concrete Paving".

# SECTION 32 30 00 – SITE AND STREET FURNISHINGS

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following site and street furnishings:
  - 1. Bike Racks
  - 2. Benches.
  - 3. Trash receptacles.
- B. Related Sections include the following:
  - 1. Section 31 20 00 "Earthmoving" for excavation for installation of concrete footings.
  - 2. Division 3 "Concrete" for formed voids in concrete footings.

### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, field-assembly requirements, and installation details.
- B. Samples for Verification: Provide a color chart for selection, actual samples are not necessary.
- C. Product Schedule: For site furnishings. Use same designations indicated on Drawings.
- D. Material Certificates: For site furnishings, signed by manufacturers.1. Recycled plastic.
- E. Maintenance Data: For site furnishings to include in maintenance manuals.

# 1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of site and street furnishings through one source from a single manufacturer.

# 1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Bench Replacement Slats: Not less than two full-size units for each size indicated.
  - 2. Trash Receptacle Inner Containers: 1 full-size unit.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. Basis-of-Design Products: Subject to compliance with requirements, provide the following products by or a comparable product by another manufacturer approved by Architect prior to bid, giving preference to products manufactured within a 500-mile radius of the Project Site.
  - 1. Bike Racks: Victor Stanley, Inc; Model BRWS-101 (in-ground mounted, with powder coat over a galvanized finish (color selected by architect))
  - 2. Bench: Victor Stanley, Inc.; Homestead Series Model 32.
  - 3. Trash Receptacles: Victor Stanley, Inc.; Model ES-242.

### 2.2 MATERIALS

- A. Steel: Free from surface blemishes and complying with the following:
  - 1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
  - 2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53, or electric-resistance-welded pipe complying with ASTM A 135.
  - 3. Tubing: Cold-formed steel tubing complying with ASTM A 500.
  - 4. Sheet: Commercial steel sheet complying with ASTM A 569/A 569M.
- B. Plastic: Color impregnated, color and UV-light stabilized, and mold resistant.
  - 1. Recycled Polyethylene: Fabricated from not less than 96 percent recycled, purified, fractional-melt plastic resin for not less than 90 percent recycled post-consumer waste by weight content HDPE.
- C. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard, corrosion-resistantcoated or noncorrodible materials; commercial quality; tamperproof, vandal and theft resistant; concealed, recessed, and capped or plugged. Provide as required for site furnishings' assembly, mounting, and secure attachment.
- D. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

# 2.3 BIKE RACKS:

- A. Frame: Steel.
- B. Table Height: As indicated by basis-of-design product.
- C. Overall Width: As indicated by basis-of-design product.
- D. Overall Depth: As indicated by basis-of-design product.
- E. Weight: As indicated by basis-of-design product.
- F. Color: As selected by Architect from manufacturer's full range.

# 2.4 BENCHES:

- A. Frame: Steel.
- B. Seat and Back: Plastic; formed from evenly spaced parallel slats.
- C. Arms: None.
- D. Seat Height: As indicated by basis-of-design product.
- E. Overall Width: 6 feet.
- F. Overall Depth: As indicated by basis-of-design product.
- G. Weight: As indicated by basis-of-design product.
- H. Seat Surface Shape: As indicated by basis-of-design product.
- I. HDPE Color: As selected by Architect from manufacturer's full range.

# 2.5 TRASH RECEPTACLES

- A. Materials: 3/8" x 1" vertical solid steel bar; 1/4" x 2-1/2" horizontal solid steel bands; 3/8" x 3" steel support bars; 5/8" solid steel top ring; 36 gallon capacity high density plastic liner; leveling feet with a 3/8" diameter threaded steel shaft
- B. Lids and Tops: Formed lid attached to the frame with two vinyl-coated steel aircraft cables.
- C. Style: As indicated by basis-of-design product.
- D. Weight: As indicated by basis-of-design product.
- E. Liners: High-density plastic liner.
- F. Capacity: Not less than 24 gal.
- G. Installation Method: Anchored to cast in place concrete.

# 2.6 FABRICATION

- A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross

section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

- D. Steel and Iron Components: Galvanized, galvanized and color coated, or color coated. Bare metal steel or iron components are not permitted.
- E. Exposed Surfaces: Polished, sanded, or otherwise finished; smooth all surfaces, free from burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- F. Factory Assembly: Assemble components in the factory to the greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

# 2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

# 2.8 STEEL AND GALVANIZED STEEL FINISHES

A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester-TGIC, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions, unless more stringent requirements are indicated. Complete field assembly of site and street furnishings, where required.
- B. Unless otherwise indicated, install site and street furnishings after landscaping and paving have been completed.
- C. Install site and street furnishings level, plumb, true, and securely anchored or positioned at locations indicated on Drawings.

# 3.3 CLEANING

A. After completing site and street furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

# SECTION 32 30 10 - MODULAR PLAYGROUND EQUIPMENT

# PART 1 – GENERAL

- 1.1 RELATED DOCUMENTS:
  - A. Drawings and general provisions of contract, including General Conditions and Supplementary Conditions and Division 1 Specification Sections, apply to the Work of this Section.
- 1.2 RELATED WORK:
  - A. Section 31 20 00 "Earthmoving"
- 1.3 DESCRIPTION OF WORK:
  - A. This Section shall be used as a standard of quality for equipment.
  - B. Provide and install modular playground structure, complete with all play components, fasteners, supports and footings, ground cover and timber edging. Locate in area indicated on Drawings. Provide ground cover and edging in profile and extent as indicated.
- 1.4 QUALITY ASSURANCE:
  - A. Safety Requirements: Design playground components to avoid snagging of clothing and entrapment of hands, arms, or other body parts. Equipment shall conform to the following:
    - 1. US Consumer Product Safety Commission (US CPSC) Guidelines: Handbook for Public Playground Safety.
  - B. Single Source Responsibility: All playground components and accessories shall be supplied by one manufacturer.
  - C. Erection of the equipment shall be performed by an installer authorized and approved by the Manufacturer.

# 1.5 SUBMITTALS:

- A. Product Data: Submit Manufacturer's technical data for materials, including catalog information for major components, anchors, fasteners and other accessories along with information on finishes. Provide Manufacturer's standard installation procedures.
  - 1. Submit location of product manufacture and of extraction/recovery of primary raw materials.
  - 2. Submit recycled-content data, designating percentages of post-consumer and post-industrial recycled material.
  - 3. Submit certification of non-CCA wood treatment for timber edging.

B. Shop Drawings: Submit shop drawings indicating layout of specified components, details for anchoring and fastening of individual components, details of support and foundations, and any other fabrication or erection information not fully described by the product literature.

# 1.6 WARRANTIES:

- A. Provide Manufacturer's standard warranty on main support components to cover structural failure due to corrosion, deterioration or defects in workmanship.
- B. Provide Manufacturer's standard one (1) year warranty covering defects in materials and workmanship for playground components except as noted below:
  - 1. Structural (Main Components): ten (10) years
  - 2. Plastic: five (5) years

# PART 2 – PRODUCTS

# 2.1 APPROVED MANUFACTURERS:

- A. Game Time c/o West Recreation
  - a. Vendor ID # 6694
  - b. P.O. Box 487, Queenstown, Maryland 21658
  - c. 800.233.0529
- B. Max Play Fit, LLC
  - a. Vendor ID # 15341
  - b. 1945 Melson Way, Hockessin, Delaware 19707
  - c. 800.574.3033
- C. Playground Specialists, Inc.
  - a. Vendor ID # 12519
  - b. 17352 North Seton Avenue, Emmitsburg, Maryland 21727
  - c. 301.271.9234
- D. Taylor Sports and Recreation
  - a. Vendor ID # 974
  - b. P.O. Box 1706, Martinsburg, West Virginia 25402
  - c. 304.263.7857

# 2.2 MATERIALS:

- A. General Design Requirements
  - 1. Straight Slides (including pipe slides) without transition sections at the base of the slide shall not exceed 30 degrees of incline. Slide "fall zones" shall comply with US CPSC guidelines.
  - 2. Provide adequate "no encroachment zone" around entire perimeter of playground area.
  - 3. Overall height of equipment shall not exceed 6'-6", except for fireman's poles which shall not exceed 10 feet in height.

- 4. Fastening, Fabrication and Finish details: Protruding bolts, sharp or jagged edges, non-capped open-ended pipes or other openings shall not be acceptable. Piping or other supports shall not extend more than 2" beyond a locking collar.
- 5. Foundations: The minimum specifications for the diameter, depth and excavation of footings shall be as follows:
  - a. Poles up to and including 6" in diameter: 12" in diameter and 3 feet in depth.
  - b. Poles exceeding 6" in diameter: Diameter shall be twice the pole diameter and 3 feet in depth.
- B. Ground Cover and Drainage: Provide treated wood mulch over the entire area indicated on the drawings, to a minimum depth of 12". Coordinate with drawings to ensure adequate drainage under the ground cover, and to avoid ponding. Maximum allowable slope shall be 2%.
  - 1. Acceptable ground covers: "Surflex", "Fibar", "Wood Carpet", or approved equal.
- C. Edging: Provide timber border around entire perimeter. Timber shall be pressure treated for ground contact with non-CCA treatment materials (0.40 #2 or better; ACQ is an acceptable wood treatment)); recycled and/or creosoted timber shall not be acceptable.
  - 1. All edges shall be 1/2" radius.
  - 2. All lumber shall be free from splinters.
  - 3. Two tiers of lumber shall be provided with rowlock or half-lapped joints. Bottom tier of lumber shall be staked to the ground with steel rods reinforcing bars, 1/2" round, 36" on center, and 24" deep.
  - 4. Top and bottom tiers shall be spiked together using galvanized fasteners.
- D. Support Posts: 5" O. D., 11 gauge minimum galvanized steel with plastic coated end caps.
- E. Fasteners: Provide self-locking nuts or other devices to prevent loosening of assemblies. All fasteners shall be galvanized, cadmium plated, or otherwise treated to prevent rusting.
- F. Metal Decks: Perforated, non-skid.
- G. Fireman's Pole (Sliding Pole): Fabricated from 1 5/8" O. D. galvanized steel pipe.
- H. Spiral Slide: Polyethylene composition with the following features:
  - 1. Center Tube: 3 1/2" O. D. 11 gauge minimum galvanized steel.
  - 2. Front Leg: 1 1/2" O. D. 11 gauge minimum galvanized steel.
  - 3. Slide shall rest flush on the upper platform.
- I. "Ring Trek" Traveling Rings: Provide six (6) high tensile strength aluminum rings, plastic coated, with swivel joint and clamp attachment to supports. Beam:

2 3/8" O. D., galvanized.

- J. "Curly" Climber:
  - 1. General: Climber shall have no gaps greater than 3 1/2", and less than 9" between coils. Design shall not allow passage of children into the interior of the coil.
  - 2. Coils shall be fabricated from not less than 1 5/6" O. D. galvanized steel pipe.
  - 3. Center support post shall be fabricated from not less than 1 5/8" O. D. galvanized steel pipe.
- K. Double Wide Plastic Slide: Single piece, UV stabilized molded polyethylene with average thickness of 5/16" and integral color. Sides shall be 8" high above the slide surface; center divider shall not have gaps. Width of slide bedway shall be 16" minimum.
- L. Horizontal "Challenge" Ladder: 2 3/8" O. D. galvanized plastic-covered outside rails, with eight (8) rungs consisting of 1 1/4" O. D. galvanized steel welded to the rails at 12" on center.
- M. Arched Chain Climber: One-piece, all welded construction. Side rails shall be 1 5/8"
   O.C. galvanized steel pipe, arched, and spaced 30" center to center. Chain: 4/0 steel with oven cured PVC "no pinch coating"; or galvanized coating.
- N. Recycled-plastic: Recycled HDPE or other recycled plastic components may be used if approved in advance by FCPS.

# PART 3 – EXECUTION

# 3.1 INSPECTION:

A. Installer and Owner's Representative shall examine the area and conditions under which the playground equipment will be installed. Do not proceed until all conditions, which would be detrimental to the installation, are corrected.

# 3.2 INSTALLATION:

- A. General: Install the playground equipment in accordance with the Manufacturer's recommended procedures and installation sequence. All equipment shall be rigid, straight, plumb and level. Secure all equipment with Manufacturer's fastening devices.
- B. Foundations: All support holes shall be filled with concrete to the full-required depth. The top of the concrete shall be 6" below finished grade. All primary supports shall be temporarily supported until concrete has sufficiently cured.
- C. Secure timber edging in place by spiking as specified herein. Rods shall not protrude beyond the face of the timber.

- D. Fasteners: All in-place bolts shall be cut flush with the nut, and peened and filed. Selflocking nuts or other devices must be provided to prevent nut and bolt assemblies from loosening or coming apart.
- E. Welds: Ensure that all welds are protected with rust inhibiting paint.
- F. Metal Connectors: Secure with pins or spot welding to prevent loosening of the connection.
- 3.3 CLEAN-UP:
  - A. Remove all debris, excess materials, tools and excess excavation spoils from the project area and dispose of legally.
- 3.4 WASTE MANAGEMENT:
  - A. Recycle waste materials in accordance with Division 1 "Construction Waste Management" requirements.

# Ċ

#### SPECIFICATIONS-ELEMENTARY APPARATUS PROPOSAL FOR AGES 2-12

#### 1. Number of Participants

The number of students may range from one class of approximately 30 students, an entire grade level of students, to multiple grade levels at the same time of approximately 200 students. Each playground apparatus; one for grades PreK/K (K-100), one for grades 1-2 (P-200), and one for grades3-5 (I-300) shall allow for a child capacity of at least 75 students and include the elements listed below.

#### 2. Space Reguirements

Three separate Playground types of Apparatus Areas shall include:

- K -100 Pre-Kindergarten and Kindergarten Play Area (certified for ages 2-5)
- P -200 Primary area (certified for ages 5-12)
- 1 300 Intermediate area (certified for ages 5-12)

#### 3. Specifications (minimum)

3.1. Manufacturer must be ISO 9001/2000 certified and have IPEMA certification for each component that shows conformance to ASTM-F1487-07ael

3.2. The Pre-K/K area will be fenced. (by others)

3.3. Each area must be ADA accessible.

3.4. Safety surfacing shall be engineered wood fiber for all three playgrounds apparatus areas. Surfacing that is more ADA-friendly (especially for wheelchairs), such as poured-in-place rubber surfacing will be bid as an alternate.

3.5. Playground apparatus hardware shall be stainless steel that resists rust and corrosion and is tamper-proof.

3.6. Playground apparatus decks and tubing shall be constructed with 12-gauge steel.

3.7. Playground apparatus powder coating shall be resistant to chipping and color fade resistant.

3.8. Playground apparatus shall have a minimum of 5-inch diameter posts for grade 1-5 and 3 % inch diameter posts (minimum) for the PreK-K area.

3.9. Playground apparatus component attachments should not overlap deck surfaces.

3.10. There shall be an eight foot maximum deck height for the I-300 (grades 3-5) area, a six foot maximum deck height for the P-200 (grades 1-2 area), and a five foot maximum deck height for the K-100 (grades PreK-K) area.

3.11. There shall be an element of flow and continuous movement among all of the elements of the playground apparatus. This element of flow shall allow students to develop their cardiorespiratory endurance as well as their muscular strength and endurance as they move through the playground apparatus.

### 4. FCPS Minimum Standards for Each Playground Apparatus Area

NOTE: \*\*Many playground apparatus components can incorporate multiple elements. 4.1 Spinning/ Swinging/ Swiveling

4.1.1 There shall be a minimum of four swinging/ spinning/ swiveling elements. "Traditional" swings (with bays as a separate apparatus) shall not be included.

ŧ

(

4.1.2 On the K-100 - Pre-Kindergarten and Kindergarten Play Area (certified for ages 2-5) There shall be a minimum of one swinging/spinning/swiveling element

#### 4.2 Climbing and Brachlating

4.2.1 For the P-200 and I-300 Playgrounds, a minimum of 6 components shall be provided for climber and overhead component play. At least two of these components shall provide for brachlating (am-over-am) skill development. At least one component shall be a climbing wall that links to a deck no higher than 6 feet. At least one component shall be a net climber. At least one component shall have dynamic motion. At least one component shall link to a deck or other component. At least one component will allow students to perform a pull-up/chin-up exercise. Climbing poles (like a "fireman's pole") shall not be included

4.2.2 On the K-100 - Pre-Kindergarten and Kindergarten Play Area (certified for ages 2-5) there shall be a minimum of 2 components for climber and overhead component play. One component shall provide for brachiating (arm-over-arm) skill development and shall be short in length

#### 4.3 Sliding

4.3.1 A minimum of 3 slides shall be in place. No tube slides shall be included.

#### 4.4 Balancing and Rocking

4.4.1 A minimum of two balance activities shall be included. Log roll type elements shall not be included.

#### 4.5 Linking Components and Ramps

4.5.1 A minimum of 3 linking components shall be used. At least one component shall incorporate brachiating. At least one component shall incorporate balance skills. At least one component shall incorporate climbing skills. No crawl tubes, tunnels, or track rides type elements shall be included.

4.5.2 Ramps are linking components used as access for all children, but are necessary for children with disabilities. A minimum of one ADA wide-ramp should be provided to allow access for students to a higher deck height (deck height that is a minimum of 3 feet). The width of this ramp should be a minimum of 74 inches in order to provide dual access for handicapped and typical students. This ramp should provide access to at least four ADA-accessible components

#### 4.6 Panels and ground level play components.

4.6.1 A minimum of two interactive play panels shall be included. At least one panel shall be placed in the "crow's nest" position adjacent to the ramp so that a student in a wheelchair can fully access the component

4.6.2 The space under platforms and decks are places for children to congregate and interact. The roofs provided by this create an enclosed space, and add to its appeal as gathering space. These spaces shall include ground level components; however, supervision of these components shall be considered in their placement.

4.6.3 A minimum of 5 ground level play components that address a variety of needs, including socialization, manipulation, imaginative play, balance, and/or auditory stimulation, shall be included.

#### 4.7 Shade Structures

The majority of the apparatus surface area shall be shaded, with particular care that slides are shades. Shade structures shall be bid as an alternate.





Grimm + Parker Architects Project No. 21740.00

33 32 23 - 9



-----



# SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including the General Conditions and other Division 1 Specification Sections, apply to the work of this Section.

### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Materials and Work Required to Construct Chain Link Fence and Gates and Related Accessories.
- B. Related Sections:
  - 1. Section 31 20 00: Earthmoving
  - 2. Section 32 13 15: Concrete Curbing
  - 3. Section 32 12 16: Hot-Mixed Asphalt Pavement
- 1.3 CODES:
  - A. Existing Underground Utilities: Refer to Section 31 20 00 "Earthmoving".
- 1.4 STANDARDS:
  - A. Installation shall be per chain link manufacturer's standards (CLFMI).
- 1.5 SUBMITTALS:
  - A. Submit manufacturer's descriptive literature, specifications and installation instructions for chain link fence and gates.
  - B. Leed Submittals: Comply with Section 018113
    - 1. MR Credit: 3: BPDO Sourcing of Raw Materials
      - a. For recycled content materials: Documentation indicating percentages by weigh of

#### pre-

consumer and post-consumer recycled content. Include materials cost value.

- C. Warranty:
  - 1. Submit typewritten vinyl coated fence warranty signed by manufacturer and contractor.

# 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver chain link fencing to the project site in original unopened containers bearing manufacturer's label.

# 1.7 QUALITY ASSURANCE:

A. Provide complete fencing (of each type) produced by a single manufacturer.

### 1.8 PROJECT CONDITIONS:

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Limitations: Do not proceed with fencing installation until underground utility, bituminous concrete pavement and concrete curb and gutter construction is complete.

### 1.9 WARRANTY:

A. Warrant vinyl coated fencing for 10 years against peeling, cracking and corrosion.

# 1.10 CONSTRUCTION SURVEYS:

- A. Retain the services of a locally registered land surveyor or professional engineer to provide horizontal alignment stakes for fencing located adjacent to site property lines. Horizontal stake interval 50 feet maximum, and at all angle points along property line.
- B. Provide horizontal alignment stakes for project site fencing. Horizontal stake interval 50 feet maximum and at all corner points.

# PART 2 - PRODUCTS

# 2.1 CHAIN LINK FENCING:

- A. Acceptable Manufacturers, giving preference to products manufactured within a 500-mile radius of the Project Site:
  - 1. Anchor Fencing
  - 2. Sonco Fence
  - 3. Long Fence
  - 4. P&H Tube Division/Southwestern Pipe
  - 5. Allied Tube and Conduit Corp.
  - 6. Other pre-bid approved manufacturer(s) meeting the requirements of this Specification Section will be considered in accordance with Specification Section 01 60 00: Product Requirements.
- B. General: Posts, rails, braces and bracing assemblies shall be high tensile steel pipe, cold-rolled and electric resistance welded from steel conforming to ASTM A 569, and hot-dip galvanized to ASTM A 525 G-90 zinc weight both inside and outside the pipe.
- C. Finish: The outsides shall receive a conversion coating and fusion bonded polyester powder coating equivalent to "Lifecoat LCX" by P & H Tube. Coating color shall be black.
  - 1. All fencing except shall have bottom tension wire.
  - 2. All fencing shall have continuous top rail.
- D. Fabric: 9-gauge (0.148-inch) core size, finished steel wires, galvanized in accordance with ASTM A 641-71a. Finish shall be thermally bonded PVC over galvanized steel, Class 2B, in accordance with ASTM F 668. Coating color shall be black. Fabric shall have 2-inch diamond mesh pattern with top and bottom selvages knuckled.

- E. Fencing and gate around generator and transformer shall be-chain link.
- F. Posts, Rails and Braces:
  - 1. Terminal Posts (Corner Posts): Up to 6 feet: 2.375 inch O.D.; over 6 feet: 2.875 inch O.D.
  - 2. Line Posts: Up to 6 feet: 1.90 inch O.D.; over 6 feet: 2.375 inch O.D..
  - 3. Gate Posts (Hinge Posts): Leaf widths up to 6 feet: 2.875 inch O.D.; leaf widths 6 feet to 13 feet: 4.00 inch O.D.
  - 4. Top Rail, Center Rail and Bottom Rail: Manufacturer's longest lengths, with expansion couplings (approximately 6 inches long) for each joint. Provide means of attaching top rail securely to each corner, end, and pull post.
  - 5. Terminal and Gate Post Bracing Assemblies: Manufacturer's standard adjustable brace at end posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for braces. Brace line posts with 0.375-inch diameter rod and adjustable tightener.
  - 6. Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross section of 3/16" x 3/4". Provide one stretcher bar at each end post and two for each corner and pull post, except where fabric is integrally woven into post.
- G. Gates:
  - 1. Gate framing shall be 2-inch square aluminum tube with fabric installed inside the frame with "J" bolts.
  - 2. Hinges shall be manufacturer's standards.
  - 3. Latches shall be butterfly type.
  - 4. Height shall match adjacent fencing fabric, leaf swings 180 degrees.
- H. Bottom Tension Wire: 7-gauge, O.D. = 0.177-inch core size, with PVC coating.
- I. Post Tops (Caps): Weathertight closure caps, dome type, at each post, with openings to permit passage of top rails.
- J. Hardware and Accessories: Galvanized per ASTM A 152 with manufacturer's standard polyvinyl chloride (PVC) plastic resin finish over galvanizing, not less than 0.010" thick.

# 2.2 CHAIN LINK FENCING HEIGHTS:

A. Heights shall be as indicated or as specified:

# 2.3 PADLOCKS:

A. Padlocks manufactured by Master Lock Company, Milwaukee, Wisconsin. Provide one "Steel Secret Service" lock and furnish Owner with two keys for each gate.

# 2.4 CONCRETE:

A. Class "B" Portland cement concrete, Specification Section 33 10 00: "Utility Standards".

# PART 3 - EXECUTION

# 3.1 PROTECTION AND RESTORATION:

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Existing Utilities: Verify utility locations prior to fencing excavation operation. Adjust horizontal fencing alignment to avoid utilities at no increase to contract sum.

# 3.2 GRADING:

A. Grade fence lines to smooth and uniform surfaces, free of depressions and high spots exceeding four inches in ten feet.

### 3.3 CHAIN LINK FENCING:

- A. General: Install in accordance with manufacturer's installation instructions and as noted. Install corner posts at horizontal alignment changes exceeding 30 degrees. Install line posts at intervals not exceeding ten feet. Install gateposts on both sides of gate opening.
- B. Post Installation:
  - 1. Excavate post footings to minimum 18-inch diameters and 39 inch depths or as otherwise indicated.
  - 2. Place and consolidate concrete in footing excavations. Install posts in concrete plumb to 1/4 inch in 10 feet. Provide bracing to prevent movement. Embed line post in concrete to 18 inches, terminal and gate posts to 24 inches. Slope exposed concrete footing surface one inch with outside edge flush with ground surface. Trowel exposed concrete footing surface to smooth finish. Contractor shall allow concrete footings to cure a minimum of 14 calendar days before removing bracing, or performing subsequent fencing operations.
- C. Terminal and Gate Post Bracing Assemblies, Truss Rods and Tighteners and Tension Wire and Post Tops: Install in accordance with manufacturer's installation instructions and as specified.
- D. Fabric: Each span shall be attached independently at pull and corner posts. Ends of fabric rolls and other section to be spliced shall be joined by weaving a single strand of the fabric wire into ends of the fabric to create a continuous pattern of mesh. Fabric shall be stretched taut and securely fastened to each post and rail. Fastenings at ends, gates, corners, and pull posts shall be with stretcher bars and metal bands.

# 3.4 MAINTENANCE:

A. Refer to Section 31 20 00 "Earthmoving".

# SECTION 32 32 23 - SEGMENTAL RETAINING WALLS

# PART 1 – GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Modular block retaining wall system.
  - 2. Precast concrete retaining wall caps.
- B. Related Sections include the following:
  - 1. Division 2, Section 31 20 00, "Earthmoving"

# 1.3 PERFORMANCE REQUIREMENTS

- A. Employ a qualified Professional Engineer licensed in the State of Maryland to design all segmental block retaining walls in accordance with the wall manufacturer's specifications and based upon information, including, but not limited to, soil properties, bearing capacities, and existing and proposed construction provided in the project Geotechnical Engineering Report and shown on the Contract Drawings, plans, profiles, details and notes. Review and request clarification of any information provided prior to submittal of bid to ensure that all Work costs are included in the Contractor's bid.
- B. Design and construct all segmental block retaining walls to be capable of resisting all soil, hydrostatic and other applied pressures. Provide all wall construction, wall materials, backfill materials, geo-grid and/or other soil reinforcement materials required to accomplish this at no additional cost to the Owner.
- C. Design and construct all segmental block retaining walls to lines and grades indicated on the Contract Drawings and to other dimensions and depths required so as not to destabilize or be de-stabilized by, or undermine or be undermined by, adjacent construction.
- D. Install segmental retaining walls without damaging existing buildings, pavements, and other adjacent site improvements.
- E. Obtain building permit for segmental retaining walls from authorities having jurisdiction. Submit a copy of said permit to the Owner for record.

# 1.4 SUBMITTALS

A. Product Data: Include data for proposed materials, method of installation, and list of materials proposed for use.

- 1. Material description and installation instructions for each manufactured product specified including Segmental Retaining Wall Units (SRW) and Geosynthetic Reinforcement.
- 2. Name and address of the production facility where the proposed SRW units will be manufactured. All units to be manufactured at the same facility.
- 3. Notarized letter from the SRW manufacturer stating that the units supplied for this project are manufactured in complete compliance with Section 2.3 of this specification. The letter shall state that the SRW units shown in the attached test reports are representative samples of the plants normal mix design and regular production runs. Include location of product manufacture.
- B. Shop Drawings, System Designs and Calculations: Prepared by or under the direct supervision of a qualified Professional Engineer licensed in the State of Maryland who is experienced in the design of the proposed segmental retaining wall system. Include drawings and comprehensive engineering analysis that shows the system's compliance with specified requirements. Engineering design calculations prepared in accordance with the NCMA Design Manual For Segmental Retaining Walls, most current edition. Analysis shall include: Internal, External, Global Stability, and Bearing Capacity Calculations. System designs, materials, calculations and shop drawing must be signed and sealed by the qualified professional engineer responsible for their preparation and must be submitted to, reviewed by, and bear the approval stamp of authorities having jurisdiction prior to their submittal for review and approval by the Architect, Engineer and/or the Owner.
- C. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of concrete units required shall be submitted to the Architect and Owner for review and approval.
- D. Samples for Verification: Full-size units of each type of concrete unit for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
- E. Test Reports:
  - 1. Independent laboratory reports indicating compressive strength, moisture absorption and freeze-thaw durability of the concrete retaining wall units from the proposed production facility. Only test performed within the past 12 months will be considered current and valid.
  - 2. Independent test reports verifying the long-term design strength properties (creep, installation damage, and durability) and soil interaction properties of the geosynthetic reinforcement.
  - 3. Independent test reports verifying the connection capacity between the geosynthetic reinforcement and the concrete retaining wall units.
  - 4. For projects with walls in excess of 25' in height, a completed Highway Innovative Technology Evaluation Center (HITEC) report shall be required for the proposed system.
- F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with
project names and addresses, names and addresses of Architects and Owners, and other information specified.

- G. LEED Submittals: Comply with Section 018113.
  - 1. MR Credit 3: BPDO Sourcing of Raw Materials
    - a. For recycled content materials: Documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include material cost value.
    - b. For regionally sourced materials: Documentation indicating locations of recovery, manufacture, purchase of recycled raw materials.

# 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed segmental retaining wall installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance. The Retaining Wall Company must have successfully completed the Segmental Retaining Wall training and exam of the National Concrete and Masonry Association.
- B. Source Limitations: Obtain each type of concrete unit from one source with resources to provide materials and products of consistent quality in appearance and physical properties.
- C. Engineering Responsibility: Contractor shall engage a qualified Professional Engineer who will be responsible for the preparation of designs and data for the segmental retaining walls including drawings and comprehensive engineering analysis that shows the system's compliance with specified requirements.
- D. Professional Engineer Qualifications: A professional engineer, in good standing, who is legally qualified and currently licensed to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services for designing segmental retaining walls that are similar to those indicated for this Project in material, design, and extent.
- E. Arrange for and obtain any required inspections and certifications by authorities having jurisdiction.
- F. Provide as-built information as required by contract and by authorities having jurisdiction.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect materials during storage and construction from earth and other materials. Protect segmental retaining wall materials from damage. Do not incorporate damaged materials into the retaining wall structure.

## PART 2 – PRODUCTS

## 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following, giving preference to products manufactured within a 500-mile radius of the Project Site:
  - 1. Available Manufacturers:
    - a. Versa-Lok Retaining Wall Systems
    - b. Keystone Retaining Wall Systems, Inc.
    - c. Anchor Wall Systems
    - d. Tensar Earth Technologies, Inc.
    - e. Rockwood Retaining Walls, Inc.
    - f. Cornerstone Wall Solutions, Inc.

# 2.2 COLORS AND TEXTURES

- A. Colors and Textures:
  - 1. Modular Block Retaining Wall Units: As selected by Architect from manufacturer's full range.
  - 2. Precast Concrete Retaining Wall Caps: Match color of color-conditioned concrete retaining wall.

# 2.3 MODULAR CONCRETE RETAINING WALL SYSTEM:

- A. Modular Concrete Retaining Wall System: Use wall system materials and construct in accordance with the wall engineer's design and wall manufacturer's specifications to meet all performance requirements set forth in this specification.
- B. Concrete Units: Comply with ASTM C1372 and the following requirements:
  - 1. Face Finish: Sculptured rock face in angular tri-planar configuration or as otherwise approved by the Owner.
  - 2. Strength: Minimum 28-day compressive strength of 3000 psi.
  - 3. Maximum Moisture Absorption: 8 percent.
  - 4. Concrete Units: Provide concrete units, mini, cap and end units provided by the wall manufacturer for use with the selected wall system and as required to meet the performance requirements set forth in this specification.
- C. Base Leveling Pad Material: Provide and install continuous footing or base material required by the wall manufacturer and wall engineer for use with the selected wall system to meet the performance requirements set forth in this specification. Do not exceed soil bearing limitations.
- D. Unit Fill: Provide and install unit fill material required by the wall manufacturer and wall engineer for use with the selected wall system to meet the performance requirements set forth in this specification.
- E. Backfill Material: Provide and install backfill material required by the wall manufacturer and wall engineer for use with the selected wall system to meet the performance requirements set forth in this specification. Where possible use site excavated soils. Do

not use unsuitable soil for backfill. Comply with Section 31 20 00 "Earthmoving" for backfill requirements.

- F. Soil and Wall Reinforcement/Stabilization: Provide and install all temporary and/or permanent soil and wall reinforcement and stabilization materials required by the wall manufacturer and wall engineer for use with the selected wall system to meet the performance requirements set forth in this specification. Such materials include, but are not limited to, high density polyethylene expanded sheet, polyester woven fiber materials, mechanical anchors, sheeting, shoring and bracing specifically fabricated for use as soil reinforcement.
- G. Non-Corrosive Connectors: Provide all pins, clips, or bars to connect successive horizontal rows of concrete blocks, possessing a verifiable strength and durability consistent with the design calculations of the wall as a whole and as required by the wall manufacturer and wall engineer for use with the selected wall system to meet the performance requirements set forth in this specification.
- H. Adhesive: Exterior grade adhesive as recommended by the retaining wall unit manufacturer.

## 2.4 CONCRETE RETAINING WALL CAPS

Except as otherwise required or recommended by the wall manufacturer and the contractor's wall Engineer for use with the selected wall system and to meet the performance requirements set forth in this specification, retaining wall caps will meet the following minimum specifications:

- A. Structural Performance: Provide precast concrete wall cap units and connections capable of withstanding design loads within limits and under conditions indicated.
- B. Materials: Comply with PCI MNL 117 and the following:
  - 1. Molds: Provide molds and, where required, form-facing materials of metal, plastic, wood or another material that is nonreactive with concrete and dimensionally stable to produce continuous and true precast concrete surfaces within fabrication tolerances and suitable for required finishes.
  - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
  - 3. Portland Cement: ASTM C 150, Type I or III.
  - 4. Normal-Weight Aggregates: Washed, inert, natural sand, or well-graded crushed stone or gravel complying with ASTM A 33 and matching aggregate used in cast-in-place retaining wall.
  - 5. Lightweight Aggregates: ASTM C 330.
  - 6. Air-Entraining Admixture: ASTM C 260, certified by manufacture to be compatible with other required admixtures.
- C. Accessories:
  - 1. Dowels: Round stainless steel bars complying with ASTM A 276, Type 304, <sup>1</sup>/<sub>2</sub>- inch diameter.

- D. Concrete Mix: Prepare design mixes for each type of concrete required. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel.
  - 1. Compressive Strength (28 Days): 5000 psi.
  - 2. Maximum Water-Cement Materials Ratio: 0.45.

## 2.5 RETAINING WALL GUARD RAILS

A. Guard Rail or Fence shall be placed directly into the cap of the retaining wall as indicated on the drawings. The engineer will be responsible for designing the wall to account for loading onto the guardrail or fence that will be mounted into the cap. Placing the guard rail or fence outside of the cap will not be accepted or approved.

# PART 3 – EXECUTION:

# 3.1 PREPARATION

A. Place leveling materials upon approved foundation to a minimum thickness of 6 inches. Compact material to provide a level surface. Compaction shall be 95 percent of Standard Proctor for sand or gravel type materials. Prepare leveling pad to ensure complete contact of retaining wall unit with base.

# 3.2 SEGMENTAL RETAINING WALL INSTALLATION

- A. Install segmental retaining walls according to modular concrete unit manufacturer's written instructions and the approved shop drawings. Use wall system materials and construct in accordance with the wall engineer's design and wall manufacturer's specifications to meet all performance requirements set forth in this specification.
- B. Except as otherwise required or recommended by the wall manufacturer and the contractor's wall engineer for construction of the selected wall system to meet the performance requirements set forth in this specification, retaining wall construction will meet the following minimum specifications:
  - 1. Place first course of concrete wall units on base leveling pad. Check units for levelness and alignment. Ensure that units are in full contact with base.
  - 2. Place units side by side for full length of wall alignment. Install non-corrosive connectors and fill voids at units with unit fill material as required by manufacturer. Tamp fill.
  - 3. Sweep excess material from top of units and install next course. Ensure each course is complete unit filled and compacted prior to proceeding to next course.
  - 4. Install Soil and Wall Reinforcement/Stabilization system, backfill and continue to lay up wall according to modular concrete unit manufacturer's written instructions and the approved shop drawings. When using geogrid, lay geogrid soil reinforcement horizontally on compacted backfill and connect to concrete wall units as indicated on manufacturer's shop drawings. Pull geogrid taut and anchor before backfill is placed on it.

# 3.3 CONCRETE WALL CAP INSTALLATION:

- A. Except as otherwise required or recommended by the wall manufacturer and the contractor's wall engineer for construction of the selected wall system to meet the performance requirements set forth in this specification, the installation of the precise wall cap will meet the following minimum specifications:
  - 1. Caps shall be formed in the field of concrete, and anchored to the top of the wall per the manufacturer's recommendations.
  - 2. Precast caps are not acceptable.

### 3.4 CONSTRUCTION TOLERANCES:

- A. Except as otherwise required or recommended by the wall manufacturer and the contractor's wall engineer for construction of the selected wall system to meet the performance requirements set forth in this specification, the installation of the precise wall cap will comply with the following as-built construction tolerances:
  - 1. Vertical Alignment: Do not vary from plumb by more than 1-1/2 inches over any 10-ft distance.
  - 2. Wall Batter: Do not vary more than 1 degrees of design batter.
  - 3. Horizontal Alignment: Do not vary more than 1-1/2 inches over any 10-ft distance.
  - 4. Corners, Bends and Curves: Do not vary 1-ft to theoretical location.
  - 5. Maximum Horizontal Gap Between Erected Units: <sup>1</sup>/<sub>2</sub>-inch.

## 3.6 FIELD QUALITY CONTROL:

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to provide quality assurance and testing services during construction. Quality testing shall include foundation soil inspection, soil and backfill testing, and observation of construction.
  - 1. Testing Frequency:
    - a. One test for every 2 feet (vertical) of fill placed and compacted, for every 50 lineal feet of retaining wall.
    - b. Vary compaction test locations to cover the entire area of the reinforced soil zone, including the area compacted by the hand-operated compaction equipment.

# END OF SECTION

## SECTION 32 90 00 - TREE CONSERVATION

### PART 1 - GENERAL

#### 1.1 DESCRIPTION:

A. This section specifies labor, materials, and equipment and services necessary for and reasonably incidental to preservation, protection and care of trees as shown on the Drawings, specified or directed.

## 1.2 QUALITY ASSURANCE:

- A. Methods for tree preservation and protection shall conform to details shown on the Drawings and any pertinent nationally recognized standards.
- B. The Contractor shall during pre-construction activities, construction activities and postconstruction activities employ an ISA (International Society of Arboriculture) certified arborist with a minimum of two years experience in tree preservation. The Contractor shall submit documentation that arborist has the above qualifications.
- C. The arborist shall be on-site at any time work is being performed in the vicinity of trees to supervise implementation of procedures for tree protection, to monitor tree health during construction operations and the installation of pipes, curbs, sidewalks, etc and to supervise any repair of damages after construction.

## 1.3 SUBMITTALS:

- A. Provide written report by a certified arborist identifying root evaluations of the trees, which are in potential conflict with construction to determine the critical root zones.
- B. Provide written report by a certified arborist indicating the best methods of construction, which will minimize the impact on the critical root zone. Obtain specifications from the arborist for individual tree protection and maintenance as required for the identified to be saved on the Drawings.

#### PART 2 - PRODUCTS

## 1.1 TREE PROTECTION DEVICE:

A. Fencing shall be tenax alpi. It shall be blaze orange plastic mesh at least forty-eight (48) inches in height, with grid openings not greater than three (3) inches in width.

### 1.2 SOIL AMENDMENTS:

- A. Suitable organic matter shall be peat moss, composted manure, deactivated sewage sludge or similar material as approved by the arborist or engineer.
- B. Special soil mixture is composed of one part suitable organic matter and 6 parts backfill. Backfill material shall be loose, fine, friable, even textured loam. The mixture shall not contain any rock fragments larger than four (4) inches in any direction, nor construction debris of any sort.

## PART 3 - EXECUTION

## 1.1 **PRECONSTRUCTION ACTIVITIES:**

- A. The limits of disturbance shall be located and flagged by the Contractor in the field prior to any stress reduction or construction activities. Limits of Disturbance shall be placed outside of critical root zones of trees to be preserved wherever possible.
- B. As shown on the plans, trees which are to be preserved shall have their roots pruned. Root pruning trenches shall be located within one foot of limits of disturbance. Roots shall be cleanly cut to a depth of at least 24 inches using a vibratory plow (cable laying machine), tooth-chain trencher or other acceptable equipment. Fill trench as soon as possible with soil mixture herein described and pack to eliminate air pockets.
- C. Fertilize trees in construction area at the rate of 3 pounds of nitrogen per 1000 square feet of root zone disturbed. Apply fertilizer to entire critical root zone out to root pruning trench. Fertilizer should be at least 50 percent (50%) slow release nitrogen and contain other essential elements and micronutrients.
- D. Water critical root zone immediately after applying fertilizer to saturate the top 6 inches of soil.
- E. A mulch 2-4 inches deep comprised of weed-free straw, woodchips, shredded bark or leaves shall be applied in the critical root zone adjacent to the pruning trench. Mulching shall not extend farther than 20 feet from the pruning trench.
- F. Trees which are dead or dying or are in poor condition prior to the start of construction shall be flagged and recorded on the plan.
- G. Blaze Orange Plastic Mesh Fence
  - 1. All tree Preservation Areas shall be surrounded by blaze orange plastic mesh fences.
  - 2. Boundaries of fencing shall be staked, flagged and approved prior to installation.
  - 3. All fencing shall be installed prior to construction activities.
  - 4. Fences shall be firmly anchored at a spacing no greater than eight (8) feet and constructed in a manner which precludes sagging.
  - 5. All fencing shall be maintained in a good condition and promptly repaired or restored as the situation warrants.

# 1.2 CONSTRUCTION PHASE

- A. Any on-site decisions regarding conditions or activities which may be injurious to the health of certain specimen trees in the vicinity of the construction area shall be made in consultation with the specified arborist.
- B. Excavated and backfill material shall not be placed or side cast within the critical root zones of trees to be preserved.
- C. Construction equipment shall not be driven into or through protected trees, nor shall swinging cranes or backhoes be allowed in their canopies.
- D. There shall be no stacking or storing supplies within the critical root zones of trees to be preserved.

- E. Trees to be removed shall be taken out without damaging protected trees.
- F. There shall be no burning in or close to protected trees.
- G. Changing site grades which will cause drainage to flow into or to collect near protected trees shall be prohibited. All grading shall take place outside the critical root zone of the trees to be protected.
- H. All equipment shall be kept outside the blaze orange fencing.
- I. In the event of drought, the protected trees shall be monitored for signs of stress and watered as needed or as directed by the arborist.
- J. The certified arborist shall also monitor trees to be preserved for any other conditions or activities not mentioned above which may be injurious to their health.

# 1.3 POST-CONSTRUCTION ACTIVITIES

- A. Repair & Care of Tree Damages
  - 1. The ends of any additional roots damaged or cut during the construction phase of the project which have not already been pruned and dressed at the outset of the project shall be cut off smoothly. Then peat moss or other suitable organic matter shall be added to the backfill material at a ratio of 1 part organic matter to 6 parts backfill. Fill and pack around roots to avoid air spaces. Restore grades to preconstruction elevations.
  - 2. Damaged limbs and dead limbs shall be removed if a safety hazard or if injurious to the health of the tree. Tree crown reduction procedures may be employed to promote the health of a tree and shall be performed by a certified arborist.
  - 3. If a tree is wounded during construction, under direction of the arborist, wounds should be cleaned, torn bark cut, and if possible the wounds dressed in a shape like a vertical ellipse, to facilitate rapid healing. Pruning knife shall be sharp and clean.
  - 4. Unless directed otherwise by the arborist, any compacted soil within the critical root zone of the trees to be preserved shall be mechanically aerated to a depth of eight (8) inches. Aeration holes should be spaced one foot on center and should be positioned to avoid severing major roots.
  - 5. The arborist shall inspect and review the trees within one-year after completion of construction and determine if the trees can be safely fertilized. The arborist shall make the initial fertilizer application and provide written instructions and information to the owner on successive fertilizer applications. After completion of construction the arborist shall perform Class II pruning on all trees to remove any damaged, dead, interfering and objectionable limbs one half inch in diameter and larger. The arborist shall selectively thin the trees to properly shape the canopy, reduce wind resistance and the possibility of storm damage.

## 1.4 REMOVAL OF TEMPORARY STRUCTURES

- A. Remove blaze orange fencing.
- B. Re-seed or sod disturbed areas in accordance with the Contract Documents.

# **END OF SECTION**

## SECTION 32 93 05 - TOPSOILING, SEEDING AND SODDING

### PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 through Division 16 Specification Sections, apply to the Work of this Section.

### 1.2 RELATED WORK

- A. Earthmoving: Section 31 20 00
- B. Landscaping: Refer to Civil Drawings and Section 32 95 00.
- C. Temporary Seeding for Erosion Control: Refer to Civil Drawings.

## 1.3 REFERENCE STANDARDS:

- A. The MDOT-SHA Standards and Specifications Manual, current edition.
- B. The MDE Erosion and Sediment Control Handbook.

### 1.4 AREAS TO BE SODDED

- A. All areas with slopes greater than 4:1. All areas between the Building and the first line of walkway or roadway around the Building perimeter, unless indicated otherwise on the drawings.
- B. All other areas shall be seeded.

#### 1.5 QUALITY ASSURANCE

- A. All sod shall be transplanted within 24 hours from the time it is harvested, unless stacked at the project site in a manner approved by the Owner's Representative. Stacked sod shall be kept moist and protected from exposure to wind and sun. Any sod permitted to dry out shall be rejected.
- B. Plant only during periods of favorable weather when conditions are suitable. Do not place sod at any time temperature is below freezing. No frozen sod shall be used, and no seed or sod shall be placed on frozen, powder-dry or excessively wet soil.
- C. Seeding: Do not proceed with seed application before or after dates specified without written authorization from the Owner's Representative or Architect.
- D. Soil amendments and rate of application shall be determined by laboratory test on soil.
  - 1. Areas to be seeded or sodded shall have a soil pH range of 6.5 7.0. Contractor shall be responsible for ensuring correct soil pH.

- 2. Test pH level in at least five equidistant locations on the site. Review with the Owner's Representative or Architect who will determine whether the average soil pH value is within acceptable range. If existing soil pH is adequate, no soil amendments are required.
- 3. If average pH value is greater than 7.0, add a commercial grade sulfur at rate derived from lab test, over area to be seeded.
- 4. If average soil pH value is less than 6.5, then agricultural limestone shall be applied at rate derived from lab test.

### 1.6 SUBMITTALS

- A. Submit statement of certification from local nursery from which sod shall be obtained.
- B. Upon request, submit square yard of sod to project site for inspection by Architect and Owner's representative.
- C. Submit certificates, signed by producer and contractor, stating that soil amendments, seed and sod comply with this specification. Certificates to include the following:
  - 1. Limestone: Type, percentage of calcium magnesium carbonates or oxides, and gradation.
  - 2. Fertilizer: Type and analysis.
  - 3. Seed: Seed mixture percentages (variety and/or specie) germination percentage, weed seed percentage and seed test date.
- D. Submit copy of laboratory test results and soil amendment recommendations for review by the Architect and the Owner's Representative.
- E. Submit the name and qualifications of a Professional Lawn Care Firm to perform lawn maintenance during the maintenance period. The firm shall be one whose primary business is lawn care. The firm must be approved by the Owner prior to completion of sod installation.
- F. Submit a proposed Lawn Maintenance Plan, detailing scheduled maintenance and compliance with the requirements of this specification. The plan shall include the name and location of the selected professional lawn care firm that will be performing the maintenance.

### 1.7 DELIVERY, STORAGE AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled and undamaged packaging.
- B. Sod: Harvest, deliver, store and handle sod in compliance with the requirements of TPI's "Specifications for Turfgrass Sod Materials," and "Specifications for Turfgrass Sod Transplanting and Installation" contained in the "Guidelines Specifications to Turfgrass Sodding".

# 1.8 GUARANTEE, INSPECTION AND FINAL ACCEPTANCE

A. Guarantee that at end of ninety days after sodding, a healthy first class lawn shall exist.

- B. Upon written request from Contractor, at least ten days before date of inspection, Owner or Architect will perform an inspection of seeded and sodded areas.
- C. After inspection, list of deficiencies or omissions requiring correction will be proposed. Items shall be corrected and are subject to same guarantee and final inspection until found acceptable. Be responsible for continued maintenance of that portion of the lawn which, after ninety days, has not been accepted by Owner.
- D. Not withstanding punch list items, Owner will certify in writing substantial completion of lawns and acceptance of work. Upon completion, reinspection of repairs or renewals necessary, Owner will assume responsibility for continued maintenance of lawn.

# PART 2 - PRODUCTS

# 2.1 TOPSOIL

A. Topsoil shall be a natural, friable, granular soil containing organic matter, uniform composition and texture, and free from clay subsoil, stones, week plant root, sticks, gravel, trash or harmful chemicals. Obtain topsoil from project site stockpiles established during clearing operations, and amend as necessary. Obtain additional topsoil required for landscape development from off-site sources and transport to the project site at no increase to contract sum. Obtain approval from Architect to supply topsoil from more than one site. Do not excavate or haul topsoil when wet or frozen. All topsoil shall meet Maryland Erosion and Sediment Control Handbook requirements.

## 2.2 SOIL AMENDMENTS

- A. Limestone: Agricultural grade limestone ground to such fineness that at least 10% passes a 100-mesh sieve, 50% passing a 40-mesh sieve, and at least 90% passes a 20-mesh sieve.
- B. Sulfur: Commercial grade sulfur of equal grade, and quality as specified for limestone.
- C. Gypsum: Agricultural grade gypsum ground to such fineness that at least 10% passes a 100mesh sieve, 50% passing a 40-mesh sieve, and at least 90% passes a 20-mesh sieve.

## 2.3 FERTILIZER

A. Fertilizer: Complete organic or inorganic fertilizer with percentages of nitrogen, phosphoric acid, potash, and trace elements determined by the soil test. Fertilizer shall be delivered to the site in original unopened containers that bear manufacturer's guaranteed statement of analysis. Rate of application shall be determined by the soil test.

# 2.4 MULCHES

- A. Straw Mulch: Air-dried, clean, mildew and seed free salt hay.
- B. Fiber Mulch: Biodegradable, dyed wood, cellulose fiber mulch; non-toxic, free of plant growth or germination inhibitors; maximum moisture content 15%; pH range 4.5 to 6.5

C. Tackifier: Non-asphatic, colloidal tackifier, recommended by biber-mulch manufacturer for slurry application; non-toxic and free of plant growth or germination inhibitors.

# 2.5 SOD

- A. State certified, nursery grown in nearby area, well rooted, free from disease, defects, insect infestation, or any unhealthy or abnormal condition, and free of weeds.
- B. Sod Composition:
  - 1. General Site: Tall Fescue (Drought Tolerant, Full Sun Mixture)
    - a. Certified Tall Fescue Cultivars, a mixture of at least two different types 95%
    - b. Certified Kentucky Bluegrass 5%
- C. Submit statement giving locations of property from which sod is to be obtained and submit square yard sample of sod to site if requested.

# 2.6 SEED:

- A. Seed shall be "Maryland Certified Seed", labeled in accordance with the State Seed Law. All seed used shall have been tested within the six months immediately preceding the date of sowing. The quality of the seed used shall be shown on the bag tags to conform to the specified guidelines. Purity and germination specified are minimum percentages by weight.
  - 1. Weed seed not to exceed 0.50 percent for each mixture. Noxious weed, including Johnson grass, Canada Thistle, Quackgrass and Poison Ivy are prohibited.
- B. Seed Mixture:

Туре	% by Weight	Min. % Purity	Min. % Germination	
Tall Fescue:	80	95	85	
(Provide a mixture	of at least 3	separate types,	"Rebel", "Gazelle", "Falcor	ı",
"Finelawn" or "Jaguar")				
Kentucky Bluegrass	10	95	85	
Improved				
Perennial Ryegrass	10	95	85	

1. Substitutions of seed type or percentages will be allowed only upon approval of the Owner's Representative.

## PART 3 - EXECUTION

- 3.1 FINISH GRADE
  - A. After rough grading has been completed and site cleared of construction debris, cover areas disturbed by construction or rough grade with minimum four inches of topsoil over earth to provide finish grade.
  - B. Final grades are indicated. Do not allow soil to pond. Firm topsoil by rolling to prevent washing and sinking. Degree of finish shall be that ordinarily obtained with blade grader or

scraper. Finish surface to within 0.10 foot above or below established grade elevations indicated.

## 3.2 APPLICATION OF SOIL AMENDMENTS

A. If soil amendments are required, apply at rates specified. Bond topsoil mix to subgrade and mix soil amendments uniformly into topsoil by tilling, disking or harrowing to five inch depth. Adjacent to existing trees, adjust depth to avoid disturbances of tree roots.

#### 3.3 FERTILIZING:

A. Incorporate fertilizer with soil in same manner as lime, and apply and incorporate with soil simultaneous with liming operations. Type of fertilizer and rate of application shall be as specified.

### 3.4 SODDING

- A. Sod shall be laid smooth, edge to edge, with staggered joints and immediately pressed firmly into contact with sod bed by rolling to eliminate air pockets. True and even surface shall be provided to ensure knitting without displacement of sod or deformation of surfaces of sodded areas. In ditches or swales, sod shall be placed with longer dimension perpendicular to flow of water in ditch.
- B. Following compaction, screened topsoil of good quality shall be used to fill cracks, and excess soil worked into grass with rakes or other suitable equipment. Grass shall not be smothered with excess fill soil. Exposed edges of sod shall be buried flush with adjacent soil.

#### 3.5 SEEDING

- A. Slurry Preparation: Slurry mixture for 1000 gallon tank:
  - 1. Seed Mixture: Set for minimum application rate of 350 pounds per acre or 75 pounds per tankful for lawns, 450 pounds per acre or 95 pounds per tankful for athletic field turf.
  - 2. Fertilizer: 182 pounds.
  - 3. Fiber Mulch: 310 pounds.
  - 4. Binder Additive: 20 gallons.
  - 5. Water: Fill tank.
- B. Proportionally adjust mixture quantities for tanks of different capacities.
- C. Slurry Application: Hydraulic application rate shall be 110 gallons per 1000 square feet. Application dates shall be 15 March to 15 May and 15 August to 31 October. Apply slurry mixture uniformly to prepared topsoil, in one continuous hydraulic operation. Do not begin hydraulic application until completion of topsoil preparation.

# 3.6 MAINTENANCE

- A. Ensure the establishment of a healthy, first class lawn. Be responsible for all maintenance, protection, and repair until Owner accepts planted area. Include watering, rolling, fertilizing and mowing.
- B. Maintenance shall be performed by a professional lawn care firm, whose primary business is lawn care. The Contractor shall submit the name of the lawn care firm to the Owner for approval.
- C. Maintenance and protection of seeded and sodded areas shall continue until Owner accepts lawn. Barriers, sign, and/or flags shall be used on established pedestrian circulation ways as determined by Owner to indicate areas where trespassing is not allowed.
- D. During the maintenance period repair or re-work washouts, dry areas, dead areas or erosion.

# END OF SECTION

# **SECTION 32 95 00 - TREES, SHRUBS AND GROUND COVERS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 through Division 16 Specification Sections, apply to the Work of this Section.

### 1.2 RELATED WORK

- A. Earthmoving: Section 31 20 00
- B. Topsoiling, Seeding and Sodding: Refer to Civil Drawings and Section 32 93 05.

### 1.3 REFERENCE STANDARDS:

- A. The MDOT-SHA Standards and Specifications Manual, current edition.
- B. The MDE Erosion and Sediment Control Handbook, current edition.

### 1.4 JOB CONDITIONS:

- A. Prior to beginning work, the Contractor is required to schedule and attend an on-site meeting with the Owner, Architect, in order to verify site conditions and scope of work.
- B. Proceed with and complete landscape work as rapidly as portions of site become available, working in cooperation with the construction manager and within seasonal limitations for each kind of landscape work required.
- C. Utilities: Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is authorized.
- D. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify architect or Owner's Representative before planting.
- E. Coordination with Lawns: Refer to Section 32 93 05. Plant trees and shrubs after final grades are established and prior to seeding and sodding. If planting of trees and shrubs occurs after seeding and sodding, protect lawn areas and promptly repair damage to lawns resulting from planting operations.
- F. Extent of landscape development work is shown on drawings and in schedules and specified herein.
- G. The work shall include, but not necessarily be limited to the following:1. Disposal of unused excavated material from planting excavations only.

- 2. Furnishing, protecting and planting all trees and shrubs of types and sizes specified.
- 3. Pruning, trimming, feeding, and mulching trees where trees are marked to be saved.
- 4. Mulching new planting stock.
- 5. Wrapping and staking new planting stock.
- 6. Watering new planting stock.
- 7. Furnishing and installing portable drip irrigation bags at each new tree.
- 8. Providing mulched areas for pedestrian walkways.
- 9. Providing timber edging along disturbed play areas and pedestrian walkways
- H. Subgrade elevations: Excavation, filling and grading required to establish elevations shown on drawings are specified elsewhere. Refer to Earthmoving, Section 31 20 00.

## 1.5 QUALITY ASSURANCE

- A. Subcontract landscape work to a single firm specializing in landscape work and with a record of satisfactory performance on similar projects.
- B. Quality Control:
  - 1. Comply with sizing and grading standards of the latest edition of "American Standard for Nursery Stock". A plant shall be dimensioned as it stands in its natural position.
  - 2. All plants shall be nursery grown under climatic conditions similar to those in locality of the project for a minimum of 2 years.
  - 3. Stock furnished shall be at least the minimum size indicated. Provide plants indicated with a measurement range so that only a maximum of 50 percent are of the minimum size indicated and 50 percent are of the maximum size indicated.
  - 4. Plants will be inspected and approved at the place of installation, for compliance with specification requirements for quality, size and type of specimen.

## 1.6 DELIVERY, STORAGE AND HANDLING

- A. Packaged Materials: Deliver materials in original packaging showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and storage on site.
- B. Trees and Shrubs: Provide freshly dug trees and shrubs. Do not prune prior to delivery. Do not bend or bind-tie trees or shrubs in such manner as to damage bark, break branches or destroy natural shape. Provide protective covering during delivery.
- C. Deliver trees and shrubs after preparation for planting have been completed, and plant immediately. If planting is delayed more than 6 hours after delivery, set trees and shrubs in shade, protect from weather extremes and mechanical damage, and keep rootball moist.

# 1.7 SPECIAL PROJECT WARRANTY

A. It shall be the Contractor's responsibility to water, fertilize and otherwise maintain plant materials in healthy condition, free of stress and insect infestation, until such time as the landscaping is formally accepted in writing by the Owner. The two-year warranty shall not commence until such formal notice is given by the Inspector.

- B. Warranty new trees and shrubs for a period of two years after date of Inspector's acceptance, against defects including death and unsatisfactory growth, except for defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond Landscape Installer's control.
- C. Remove and replace unsatisfactory trees or plants or those found to be dead or in unhealthy condition during warranty period. Make replacements during growth season following end of warranty period. Replace in kind and size specified and plant in accordance with this Section.

## 1.8 SUBMITTALS

- A. Submit the name and qualifications of a Professional Landscape Firm to perform Landscape installations and plant maintenance during the maintenance period. The firm must be approved by the Owner prior to beginning landscape work.
- B. Submit a proposed Planting Maintenance Plan, detailing scheduled maintenance and compliance with the requirements of this specification. The plan shall include the name and location of the selected professional Landscape firm that will be performing the maintenance.
- C. Maintenance Instructions: Submit typewritten instructions to be used by Owner for maintenance of landscape work for one full year after termination of maintenance period. Submit prior to expiration of required maintenance period(s).
- D. Submit manufacturer's catalog information and installation instructions for flexible plastic landscape edging and mulch for pedestrian walkways.
- E. Submit manufacturer's catalog information and installation instructions for portable drip irrigation bags for new trees.
- F. For products having regional material content, documentation indicating location of harvest of plants. Include statement indicating cost of each product with regional material content.

## PART 2 - MATERIALS

## 2.1 TOPSOIL

- A. Topsoil stockpiled for re-use shall be used in areas receiving seed or sod. Topsoil for planting shall be supplied from off-site sources by this Contractor.
- B. Provide new topsoil which is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 2" in any dimension, and other extraneous or toxic matter harmful to plant growth. Determine pH of topsoil and add amendments as required.
- C. Commercial Fertilizer: Complete fertilizer with some elements derived from organic sources and containing percentages of available plant nutrients recommended for each type of planting and of proper pH for each type of specimen (refer to Section 32 93 05).

# 2.2 PLANT MATERIALS

- A. Plant materials shall be classified as per "American Standard for Nursery Stock", as adopted by the American Association of Nurserymen. Plant materials not meeting this standard shall be rejected.
  - 1. Conform to requirements of the plant list.
  - 2. All plant materials shall be nursery growth stock.
  - 3. Trees shall be well branched, with full crown.
  - 4. Each plant shall be free from disease, insect infestation, and dead branches.
  - 5. Each plant shall be balled and burlapped (B&B), with rootball fully intact.
  - 6. Substitutions may be made only after submission of evidence substantiating to the Architect's and Owner's satisfaction, non-availability of specified plant items and only if approved by the Architect.
  - 7. Substitutions may be made only with Architect or Owner's approval, at same price as unavailable contract item or at lower, approved price with a credit provided.
- B. Planting Soil Mix: 3 parts by volume topsoil, 1 part by volume peat moss.
- C. Mulch: Shredded hardwood or pine bark.
- D. Deciduous Tree Wrapping: Approved tree wrapping paper 4 inch width.
- E. Stakes, guy wire and tubing: Of kind and size per drawings for proper support of specimen.

## 2.3 MULCH FOR PEDESTRIAN WALKWAYS

- A. Provide treated wood mulch over the entire area indicated on the drawings, to a minimum depth of 6".
  - 1. Acceptable ground covers: "Surflex", "Fibar", "Wood Carpet".

## 2.4 TIMBER EDGING

- A. Timber shall be pressure treated for ground contact (0.40 #2 or better); recycled and/or creosoted timber shall not be acceptable.
  - 1. All edges shall be 1/2" radius.
  - 2. All lumber shall be free from splinters.
  - 3. Two tiers of lumber shall be provided with rowlock or half-lapped joints. Bottom tier of lumber shall be set into the ground, and staked to the ground with steel rods reinforcing bars, 1/2" round, 36" on center, and 24" deep.
  - 4. Top and bottom tiers shall be spiked together using galvanized fasteners.

# 2.5 FLEXIBLE PLASTIC EDGING

A. Edging shall be flexible high density polyethylene plastic, such as "Black Diamond Landscape Edging", by Valley View Industries, 1-800-323-9369.

## 2.6 PORTABLE DRIP IRRIGATION BAGS

- A. Portable drip irrigation bags shall be UV treated polyethylene bags, reinforced with nylon webbing, with nominal capacity of 20 gallons. Bags shall be designed to be connected together to form larger units for larger trees, if needed. Bags shall be designed to be easily filled with a standard garden hose, and to release water into the root ball of the tree over sufficient time to prevent runoff. Drip irrigation bags shall be "Treegator" bags, as manufactured by Spectrum Products, Inc., Raleigh, North Carolina, 1-866-treegator (web page treegator.com).
- 2.7 Provide plants harvested within 500-mile radius of Project Site.

## PART 3 - EXECUTION

## 3.1 GENERAL

- A. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations and outline areas and secure Architect's and Owner's acceptance before start of planting work. Make minor adjustments as may be requested.
- B. Preparation for Planting:
  - 1. Planting hole: Prepare in accordance with drawings and dispose of soil removed from hole.
  - 2. Tree planting: Plants shall be set plumb, planted at same depth that plants grew in nursery.
  - 3. After placing plant in hole, planting soil mix shall be gently but firmly tamped and sufficiently watered to ensure soil contact around all roots.
  - 4. Earth saucers or water basins shall be at least four (4) inches deep with diameter equal to that of plant ball.
  - 5. Water plants thoroughly during and immediately after planting.
  - 6. Mulch to cover saucer area of individual plants.
  - 7. Wrapping shall cover entire trunk to height of first branch.
  - 8. Guy with stake locations and depth per drawings, with a minimum of three stakes per tree.
  - 9. Prune shortly after planting only when deemed necessary by Architect or Owner's Representative to remove broken and bruised branches.
  - 10. Provide and install portable drip irrigation bags at each new tree. Provide single unit bags (20 gallons) for trees with 1" to 4" trunks, and combine bags to form a 50 gallon set for trees with 4" to 8" trunks. Install in accordance with manufacturer's instructions. Fill the bags and begin scheduled maintenance.

## 3.2 MULCH WALKWAYS

A. Prior to installing mulch, treat the existing surface to be covered with a contact herbicide such as "Roundup" to kill all existing vegetation under the mulch. Then apply a preemergent herbicide to the area to be mulched.

- B. Cover the area to be mulched with a layer of filter cloth prior to installing mulch cover. Key the edges of the filter cloth layer a minimum of 6 inches down into the soil with the plastic edging, or pin the edges under the timber edging for timber edged walkways.
- C. Cover the area to be mulched with a minimum tamped thickness of six inches of treated wood mulch.

## 3.3 EDGING

A. Install flexible plastic landscape edging in accordance with manufacturer's instructions. Leave enough edging exposed above grade to contain mulch. Install flexible plastic edging and timber edging where indicated on the Drawings.

## 3.4 CLEANUP AND PROTECTION

- A. During landscape work, keep adjacent paved areas clean, and work area in an orderly condition.
- B. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.

## 3.5 MAINTENANCE:

- A. Contractor shall maintain all plants in a healthy condition. Contractor's maintenance responsibilities shall consist of pruning, watering, fertilizing, cultivating, weeding, mulching, tightening and repairing of staking, setting plants to proper grades or upright position, restoration of the planting saucer, and furnishing and applying sprays or other items as are necessary to keep the planting free of insects and disease and in thriving condition. Maintenance shall be performed by a professional Landscaping firm, whose primary business is landscaping and plant care.
- B. Maintenance shall begin immediately after each plant is planted and shall continue for a period of 60 days from the date of acceptance by the Owner.

## 3.6 INSPECTION AND ACCEPTANCE

- A. When landscape work described in this section is completed, the Architect and Owner's Representative will make an inspection to determine acceptability.
- B. Where inspected landscape work does not comply with requirements, replace rejected work and continue specified maintenance until reinspected by Architect and Owner's representative and found to be acceptable. Remove rejected plants and materials from project site, and replace with healthy specimens.
- C. It shall be the Contractor's responsibility to diligently pursue approval of the landscaping from Frederick County, and to correct punch list inspection items, prior to Owners occupancy of the new construction.

**END OF SECTION** 

# SECTION 33 10 00 - UTILITY STANDARDS

### PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 1, Specification Sections apply to work in this section.
- 1.2 DESCRIPTION OF WORK:
  - A. This section specifies materials, work and standards for site and utility construction materials and work.

### 1.3 RELATED WORK:

A. Refer to Section 31 20 00 "Earthmoving"; Section 33 41 00 "Storm Drainage", Division 22 "Plumbing" and Division 26 "Electrical".

## 1.4 STANDARDS:

- A. Maryland Department of Transportation State Highway Administration current "Standard Specifications for Construction and Materials", Measurement and Payment Clauses do not apply.
- B. American Concrete Institute (ACI).

## 1.5 SUBMITTALS:

- A. Products:
  - 1. Submit typewritten list of selected products, when options are specified, within 10 calendar days after contract execution. Submit detailed shop drawings of utility modifications required by selection of options.
  - 2. Submit manufacturer's descriptive literature of structure castings.
  - 3. Submit Portland cement concrete mix design formula for each class specified.
  - 4. Submit certificates, signed by manufacturer or producer and contractor, stating the following comply with this specification:
    - a. Portland cement.
    - b. Fine aggregates.
    - c. Coarse aggregates.
    - d. Portland cement concrete.
    - e. Concrete masonry units.
    - f. Brick.
    - g. Foundation materials.
    - h. Bedding materials.
  - 5. Submit shop drawings, of the following, indicating concrete reinforcement locations, size and placement:

- a. Cast in place reinforced concrete structures.
- b. Pre-cast reinforced concrete structures.
- 6. Submit location of product manufacture and of extraction/recovery of primary raw materials.
- B. Compaction Equipment: Submit compaction equipment data prior to start of controlled fill earthwork operations.
- C. Testing: Submit test reports of testing specified.
- D. "As-Built" Plans: Submit "as-built" plans for water, sanitary sewer and storm drainage systems. Submit to the Owner's Representative and to controlling utility agencies as required.
- 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:
  - A. Delivery: Schedule delivery operations to avoid unnecessary re-handling.
  - B. Storage:
    - 1. General: Store in accordance with manufacturer's recommendations and as noted.
    - 2. Portland cement: Store on platforms above ground and protect from adverse environmental conditions.
    - 3. Aggregates: Store to prevent foreign material contamination.
    - 4. Utility Joint Materials and Lubricants: Store in cool and dry location free of oil, grease, excessive heat and direct sunrays.
  - C. Handling:
    - 1. General: Comply with manufacturer's recommendations and as noted.
    - 2. Aggregates: Handle to prevent segregation.
    - 3. Pre-cast Concrete Structures: Handle to prevent damage. Utilize lifting holes provided by structure manufacturer.

## 1.7 DEFINITIONS:

A. Refer to Section 31 20 00 "Earthmoving".

# 1.8 **PROJECT CONDITIONS:**

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Traffic: Maintain pedestrian and vehicular traffic during utility construction operations.
- C. Limitations:
  - 1. Environmental: Do not place Portland cement products or erect masonry when ambient air temperature is below 40 degrees Fahrenheit or air temperature has been below 35

degrees Fahrenheit for twelve or more consecutive hours or between 15 November and 1 March without written authorization from the Owner's Representative or the Architect.

- D. Certifications, Inspections and As-Built Documents:
  - 1. The Contractor shall provide inspection, certification and "as-built" plans of the on-site water, sanitary sewer service and storm sewer work by a locally registered professional Engineer. Contractor shall notify the Architect within 15 calendar days of signing the contract who the Registered P.E. will be and who will certify the as-built water and sewer plan. Show any changes and include ties for the location of valves, bends, manholes, fire hydrants, and laterals accompanied by the qualifying air test date and certification of compliance. See Division One "Project Record Documents" for format of "as-built" drawings.
  - 2. All storm drain system work must be inspected by Frederick County in accordance with agency permit requirements. Record of as-built conditions will be required.

# PART 2 - PRODUCTS

# 2.1 MATERIALS:

- A. Portland Cement Concrete: SHA Section 902, Portland Cement Concrete and Related Products.
  - 1. Water: Clean and free of oil, acid and injurious amounts of vegetable matter, alkalis and salts. River, stream or lake water is prohibited.
  - 2. Forms: Wood, steel or as specified. Form materials to produce smooth surfaces, free of irregularities. Nonrented wood formwork shall be made of FSC-certified sustainably harvested wood materials.
- B. Mixes:
  - 1. Class "A" Concrete: SHA Mix No. 4, Table 902 A. 28-Day compressive strength 3500 P.S.I. Maximum 50% GGBF slag replacement for Portland cement, per MDOT-SHA Specification 902.06.05.
  - Class "B" Concrete: SHA Mix No. 2, Table 902 A. 28-Day compressive strength 3000 P.S.I. Maximum 50% GGBF slag replacement for Portland cement, per MDOT-SHA Specification 902.06.05.
- C. Concrete Reinforcements:
  - 1. Steel bars: ASTM A 615, Grade 60, deformed, designation as indicated or specified. Minimum 99% recycled-content, of which minimum 60% shall be post-consumer and the remainder may be post-industrial material.
  - 2. Steel Wire Mesh: ASTM A 185 welded wire mesh, roll type, size as indicated or specified.
- D. Brick:
  - 1. Type A: ASTM C 55 Concrete Building Brick, type I, grade N, standard manufacture

size.

- 2. Type B: ASTM C 32 Clay or Shale Brick, grade SS or as specified, solid, 2-1/4 by 3-3/4 by 8 inches.
- E. Cement Mortar: MDOT-SHA Section 902.05, Masonry Cement.
  - 1. Water: As specified for Portland cement concrete.
- F. Cast-in-Place Reinforced Concrete Structures:
  - 1. Structure Bases: Class "B" Portland Cement Concrete.
  - 2. Structure Walls and Top Slabs: Class "A" Portland Cement Concrete.
  - 3. Concrete Reinforcement, Structural Steel, Structure Castings and Appurtenances: As indicated and specified.
- G. Pre-Cast Reinforced Concrete Structures:
  - 1. Square and Rectangular Structures: ASTM C 858.
  - 2. Structural Design Loading: ASTM C 858, live load designation A-16.
  - 3. Circular Structures: ASTM C 478.
  - 4. Structure Joints: ASTM C 443.
- H. Foundation Materials:
  - 1. Type I: ASTM C 33 Coarse Aggregate, size No. 8 (3/8 inch to No. 8).
  - 2. Type II: MDOT-SHA Coarse Aggregate Size No. 57 stone (1 1/2 inch to No. 8).
  - 3. Type III: Material free of debris, waste materials, frozen materials, vegetable matter, clay, rocks or stones exceeding 1 inch in any dimension. Obtain Type III material from on-site excavations or off-site borrow areas approved by the Soils Engineer.
- I. Bedding Materials:
  - 1. Type A: ASTM C 33 Fine Aggregate.
  - Type B: ASTM C 33 Coarse Aggregate, size No. 6 (1 inch to No. 4).
    a. Contractor's Option: SHA Coarse Aggregate Size No. 57 stone (1 1/2 to No. 8.)
  - 3. Type C: Earth material free of debris, waste materials, frozen materials, vegetable matter, clay and rocks or stones exceeding one inch in any direction.
- J. Bedding Material Schedule:
  - 1. Storm drainage system: Type B, or as per manufacturers recommendations.
  - 2. Water Distribution System: Frederick County Standards, or Type A.
  - 3. Sanitary Sewer System: Frederick County Standards, or Type B.
  - 4. All other utilities: Type C.
- K. Backfill Materials: As specified for Fill or Backfill, Section 31 20 00 "Earthmoving", and as noted.
  - 1. Utility Trenches:

- a. Phase I: Earth material free of debris, waste materials, frozen materials, vegetable matter and rock or stones exceeding one inch in any dimension.
- b. Phase II: Earth material free of debris, waste material, frozen material, vegetable matter and rock or stones exceeding two inches in any dimension.
- 2. Utility Structures: Earth material free of debris, waste material, frozen material, vegetable matter and rock or stones exceeding two inches in any dimension. Obtain backfill material from the following: Excavated material approved by the Soils Engineer or the Owner's Representative.

### PART 3 - EXECUTION

- 3.1 **PROTECTION AND RESTORATION:** 
  - A. Refer to Section 31 20 00 "Earthmoving" and as noted.
  - B. General: Provide support systems (e.g. sheeting, shoring, sheet piling, cribbing, etc.) at no increase to contract sum. Cut off timber when using timber support systems above top of utility to prevent utility displacement. Exercise care when using trench shields or boxes during shield movement to prevent utility displacement.

## 3.2 EXISTING UTILITIES:

- A. Refer to Section 31 20 00 "Earthmoving", and as noted. Contractor shall notify "Miss Utility" at least 48 hours prior to start of construction.
- B. Provide test pits at all existing utility crossings prior to any system construction. Verify utility inverts for review by Architect or the Owner's Representative to determine potential conflicts prior to start of system construction.
- 3.3 DEWATERING:
  - A. Refer to Section 31 20 00 "Earthmoving".

#### 3.4 EXCAVATION:

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Trench Excavation: Open cut method or as specified. Excavate materials encountered to subgrade elevations indicated or specified.
  - 1. Trench width below top of utility not to exceed the following clearances on each side of utility:
  - 2. Utility Exterior Width,<br/>Diameter or Span<br/>1 thru 30 in.<br/>31 and higherClearance<br/>16 in.24 in.
  - 3. Excavate utility trenches to the following depths:
    - a. Circular storm drainage pipe: Six inches below bottom of pipe.
    - b. Water distribution pipe: Frederick County Standards or four inches below bottom of

pipe.

- c. Sanitary sewer pipe: Frederick County Standards or six inches below bottom of pipe.
- d. All other utilities: Bottom of utility.
- C. Structure Excavation:
  - 1. Utility structure excavation to produce 12-inch clearance between exterior structure walls and excavation walls or support systems.
  - 2. Extend excavation to the following:
    - a. Cast in place reinforced concrete structures: Six inches beyond structure base.
    - b. Pre-cast reinforced concrete structures: Six inches below bottom of pre-cast structure base.
    - c. Pre-cast reinforced concrete structure with cast in place concrete base: Bottom of structure base.
    - d. Masonry structures: Bottom of structure base.

# 3.5 OVER-EXCAVATION:

- A. Refer to Section 31 20 00 "Earthmoving", except as noted.
- B. Utility Trenches:
  - 1. Correct over-excavation of water distribution, storm drainage and gravity flow sanitary sewer systems by backfilling over-excavated trenches with Type II foundation (Type B bedding) material and compacting.
  - 2. Correct over-excavation of all other utilities by backfilling over-excavated trenches with Type III foundation (Type C bedding) material and compacting.
  - 3. Place material in loose lifts not exceeding eight inches. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698.
- C. Structures: Correct utility structure over-excavation by backfilling over-excavation with Type II foundation (Type B bedding) material and compacting.
  - 1. Place material in loose lifts not exceeding eight inches. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698.

# 3.6 UNSUITABLE EARTH:

- A. Refer to Section 31 20 00 "Earthmoving", except as noted.
- B. Restore unsuitable earth excavation as specified for over-excavation.

## 3.7 EXCAVATED MATERIAL STORAGE:

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Stockpile select excavated materials required for backfill operations.

# 3.8 PORTLAND CEMENT CONCRETE CONSTRUCTION:

- A. Mixing:
  - 1. Ready-Mixed Concrete: ASTM C 94.
  - 2. Project Site Batch Mixing: ACI 301, Chapter 7.
- B. Formwork: ACI 301, Chapter 4.
- C. Reinforcement: ACI 301, Chapter 5.
- D. Joints and Embedded Items: ACI 301, Chapter 6.
- E. Placement: ACI 301, Chapter 8.
- F. Surface Defects: ACI 301, Chapter 9.
- G. Finishes: ACI 301. Non-Exposed: Section 10.2.1. Exposed: Section 10.2.2.
- H. Curing and Protection: ACI 301, Chapter 12.
- I. Cold Weather Concreting: ACI 306R.
- J. Hot Weather Concreting: ACI 305R.

## 3.9 STRUCTURES:

- A. Cast in Place Reinforced Concrete Structures: Construct cast in place concrete structures as indicated and specified.
- B. Pre-cast Reinforced Concrete Structures:
  - Pre-cast structure base: Place Type I foundation material, on excavation subgrade, to bottom of structure base and compact to 95 percent of maximum dry density by ASTM D 698. Install pre-cast structure base, on compacted foundation material, level to 1/8 inch in 5 feet. Clean and lubricate structure joints, immediately prior to installation, in accordance with manufacturer's recommendation. Install pre-cast reinforced structure sections, on structure base, plumb to 1/4 inch in 10 feet. Position structure sections on previously installed section and push joints tightly together. Position concrete top slabs on structure as indicated. Plug lifting holes with cement mortar. Install frames and covers to finished grade with bricks and cement mortar.
- C. Masonry Structures:
  - 1. Erect structure walls with masonry materials specified. Wet each masonry unit thoroughly before placement. Shove each unit into place in full bed of cement mortar. Horizontal and vertical joints not to exceed 1/2 inch.
  - 2. Bond and Coursing: Brick Masonry Common Bond.
  - 3. Fill joints completely with cement mortar. Fit masonry units tightly around utilities

projecting through structure walls. Space, set and bond structure appurtenances as indicated or specified during masonry erection. Point up interior structure joints and clean removing excess cement mortar. Parge exterior structure walls with 1/2 inch thick cement mortar and finish with smooth trowel. Masonry construction tolerances not to exceed 1/4 inch in 10 feet vertical from plumb.

# 3.10 BEDDING:

- A. Storm drainage pipe: Place bedding material, on excavated trench subgrade to bottom of pipe and compact. Upon completion of pipe installation, place and compact bedding material to pipe springline.
- B. All Other Utilities: Bedding not required. Install utilities on excavated trench subgrade as indicated or specified by Frederick County.

## 3.11 BACKFILL:

- A. Backfill utility trenches in two consecutive phases as follows:
  - 1. Phase I Backfill to 12-inch depth above top of utility. Place backfill material in loose lifts not exceeding four (4) inches. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698.
  - Phase II Unpaved Areas: Place backfill material to grade in loose lifts not exceeding eight (8) inches. Compact each lift to 90 percent maximum dry density. Density test method: ASTM D 698
  - Phase II Paved Areas: Place backfill material to grade in loose lifts not exceeding eight (8) inches. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698.
- B. Backfill utility structures as follows: Place backfill material carefully and in loose lifts not exceeding eight (8) inches in depth. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698. Do not backfill masonry structures until cement mortar parge attains initial set.

## 3.12 EXCAVATED MATERIAL DISPOSAL:

A. Refer to Section 31 20 00 "Earthmoving".

# **END OF SECTION**

# SECTION 33 10 05 - WATER DISTRIBUTION SYSTEM

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 1, Specification Sections apply to work in this section.

### 1.2 DESCRIPTION OF WORK

A. This section specifies materials and work required to construct water distribution system.

### 1.3 RELATED WORK

A. Refer to Section 33 10 00 "Utility Standards".

## 1.4 STANDARDS

- A. Frederick County's current "General Conditions and Standard Specifications" and "Standard Details".
- B. American Water Works Association (AWWA).

### 1.5 SUBMITTALS

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. Products: Submit product manufacturer's specifications and installation instructions and certificates of compliance signed by manufacturer and contractor stating that products comply with this specification to the Architect. Certificates of compliance must be notarized, signed by an officer of the Manufacturer, and shall include job location, Contractor's name, types, classes and strengths of pipe and fittings, and the Manufacturer's name.
- C. Submit As-built drawings to the Architect.

## 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 33 10 00 "Utility Standards", and as noted.

## 1.7 PROJECT CONDITIONS

- A. Refer to Section 33 10 00 "Utility Standards", and as noted.
- B. All on-site construction and materials shall be in accordance with the latest edition of the Frederick County General Conditions and Standard Specifications, Design Manual, and Standard Details
- 1.8 CONSTRUCTION SURVEYS

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 50 feet and at all appurtenances (e.g. fittings, valves, etc.). Provide construction cut sheet preparation as required.

### 1.9 SPECIAL INSPECTIONS, TESTING OBSERVATION AND CERTIFICATIONS

A. ADDITIONAL INSPECTIONS, OBSERVATIONS AND CERTIFICATIONS: It shall be the responsibility of the contractor to hire the Engineer-of-Record to perform any additional special inspections, testing observations and certifications required beyond those specific services identified herein as being provided by the Owner.

## PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. All materials shall be Frederick County Standards and shall meet all Frederick County requirements indicated.
- B. Valve Boxes: Cast iron two-piece valve boxes, screw type box, bell base section, 5-1/4 inch shaft, round drop cover with "W" marking.
- 2.2 CONCRETE PADS: Class 'A' Portland cement.
- 2.3 CONCRETE ANCHORS: Frederick County Standards indicated and specified. Class 'A' Portland cement concrete, Section 33 10 00 "Utility Standards".

## 2.4 STRAPS AND RODS

- A. Clamps, Straps and Washers: Steel, ASTM A 506.
- B. Rods: Steel, ASTM A 575.
- C. Rod Couplings: Malleable-Iron, ASTM A 197
- D. Bolts: Steel, ASTM A 307
- E. Cast-Iron Washers: Gray-iron, ASTM A 126

#### 2.5 MISCELLANEOUS PRODUCTS

- A. Underground Identification Tape: Manufactured by Allen Systems, Houston, Texas.
  - 1. Type: "Markline".
  - 2. Color: Precaution Blue.
  - 3. Legend: Caution water line buried below.
  - 4. Tape Width: Three inches.

- B. Disinfection Products: Frederick County standards indicated and specified. For continuous feed disinfection method, use Calcium Hypochlorite: AWWA B 300, granular form.
  - 1. Contractor's Option: AWWA B 301 Liquid Chlorine.
  - 2. Contractor's Option: AWWA B 303 Sodium Chloride.
  - 3. Water: Potable.

## PART 3 - EXECUTION

- 3.1 PROTECTION AND RESTORATION:
  - A. Refer to Section 33 10 00 "Utility Standards".
- 3.2 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH:
  - A. Refer to Section 33 10 00 "Utility Standards".
- 3.3 PIPE:
  - A. General:
    - 1. Install in accordance with pipe manufacturer's installation instructions, Frederick County standards and requirements and as noted.
    - 2. Inspect each pipe laying length, pipe joint materials and fittings for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Place fittings at changes in horizontal and vertical alignment as indicated. Construct concrete anchors at each fitting as indicated. Place concrete to permit access to joints for inspection and maintenance. Apply liberal coat of coal tar pitch to exposed steel and hardware. Field cut pipe only where required to complete closures or to install fittings, valves or fire protection equipment. Cut pipe to smooth square end with equipment designed for cutting pipe.
  - B. Ductile Iron Pipe:
    - 1. Install pipe in accordance with AWWA C 600 and as noted.
    - 2. Install with bell ends facing in direction of laying operations. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed upgrade. Place identifying mark on pipe not provided with spigot depth mark. Clean interior and exterior surfaces of bell and spigot removing oil, grit, excess coating and foreign matter. Lubricate pipe ends and gasket in accordance with pipe manufacturer's instruction.
  - C. Ductile Iron Push-On Pipe: Position each laying length in previously installed pipe and push or pull joint tightly together with mechanical device designed for pipe jointing. Grind or file spigot end of field cut pipe to resemble manufactured spigot end. Place spigot identifying depth mark as specified. Pipe joint deflection not to exceed the limits specified in Table 2, AWWA C 655.

## 3.4 BURIED VALVES

A. Install valves in accordance with valve manufacturer's installation instructions, and Frederick County requirements.

# 3.5 FIRE HYDRANTS

A. General: Install fire hydrants at locations indicated, in accordance with AWWA M17 "Installation, Operation and Maintenance of Fire Hydrants", manufacturer's installation instructions, and Frederick County standards and requirements.

# 3.6 BACKFILL

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. Valve Box Installation: Install valve box for each buried gate valve during backfill operations. Install boxes to prevent shock or stress transmission to valves or pipe and center over valve operating nut plumb to 1/4 inch in five feet. Adjust box cover flush to finished grade.
- C. Underground Identification Tape: Install tape during backfill operations. Tape shall be centered over pipe, located 24 inches below finished grade.

# 3.7 SYSTEM TESTING

- A. General: Provide materials, equipment (e.g. pumps, gauges, etc.) and labor required to test system. Do not conduct tests until concrete anchors cure and set seven calendar days. Provide a minimum of 48 hours notification of planned testing. Test observation by the Architect and local governing water authority personnel. Test system in accordance with AWWA C 600 and as noted.
- B. Hydrostatic Pressure Tests: Conduct hydrostatic pressure tests, upon completion of Phase I backfill operations. Fill systems or valved section of system with water. Expel air from pipe. Slowly apply test pressure. Test pressure to be 200 PSI. Test duration to be two hours. Test pressure shall not vary more than +5 psi for the duration of the test. Examine all system joints. Correct defective products or improper system installation as directed by the Architect and local governing water authority personnel.
- C. Hydrostatic Leakage Tests: Conduct hydrostatic leakage tests upon completion of Phase II backfill operations. Test procedure as specified for hydrostatic pressure tests, except as noted. Test pressure @ 110 PSI. Test duration 24 hours. Allowable leakage for ductile iron pipe is not to exceed the limits specified in Table 3, AWWA C 600. Correct system installation exceeding allowable leakage specified as directed by the Architect and local governing water authority personnel.

# 3.8 INSPECTION AND CERTIFICATION

A. Retain the services of a Maryland-registered engineer for inspection of system construction and certification that system complies with standards specified. In accordance with the
requirements on the approved drawings, the inspecting engineer must be the engineer of record for the approved drawings.

#### 3.9 SYSTEM DISINFECTION

- A. Disinfect system in accordance with AWWA C 651, Frederick County standards specified, and as noted. Provide materials, equipment (e.g. pumps, etc.) and labor required to disinfect system.
- B. Disinfection Method: Continuous feed.
  - 1. Preliminary and final flushing velocity to be 2.5 fps. Solution concentration as specified. Maintain 50 MG/L available chlorine during 24-hour disinfection period. Bacteriologic test interval every six hours. Flushing and drainage locations where directed by the Owner's Representative.

#### 3.10 DISINFECTION TESTING

A. Conduct chlorine residual tests upon completion of final flushing operations. Repeat disinfection operation until satisfactory chlorine residual quality tests are obtained.

## 3.11 WATER BACTERIOLOGIC QUALITY TESTING

A. Retain the services of an independent testing laboratory to conduct water bacteriologic quality testing.

# **END OF SECTION**

### SECTION 33 30 00 - SANITARY SEWERAGE

### PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 1, Specification Sections apply to work in this section.

#### 1.2 DESCRIPTION OF WORK

A. This section specifies materials and work required to construct gravity flow sanitary sewer system.

### 1.3 RELATED WORK

A. Refer to Section 31 20 00 "Earthmoving", Section 33 10 00 "Utility Standards", Section 33 41 00 "Storm Drainage", and Division 22 "Plumbing".

#### 1.4 STANDARDS

- A. Refer to Section 33 10 00 "Utility Standards", and as noted.
- B. Frederick County current "General Conditions and Standard Specifications" and "Standard Details".

### 1.5 SUBMITTALS

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. Products: Submit product manufacturer's specifications and installation instructions and certificates of compliance signed by manufacturer and contractor stating that products comply with this specification to the Architect. Certificates of compliance must be notarized, signed by an officer of the Manufacturer, and shall include job location, Contractor's name, types, classes and strengths of pipe and fittings, and the Manufacturer's name.
- C. Options: Submit typewritten list of selected products when options are specified within 10 calendar days after contract execution. Submit detailed shop drawings of system modifications required by selection of options.
- D. Submit shop drawings of precast structures indicating concrete reinforcement location, size and placement.
- E. Submit As-built drawings to the Architect.
- 1.6 PRODUCT, DELIVERY, STORAGE AND HANDLING
  - A. Refer to Section 33 10 00 "Utility Standards".

### 1.7 PROJECT CONDITIONS

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. All on-site construction and materials shall be in accordance with the latest edition of the Frederick County General Conditions and Standard Specifications, Design Manual, and Standard Details.
- C. Existing Sanitary Sewer System: Provide, install, operate and maintain pumps and related equipment required to divert sewage (bypass pumping) during system construction. Extend pump discharge lines to existing sanitary sewer structures. Surface flow is prohibited.
- D. Traffic: Maintain vehicular and pedestrian traffic during system construction.

## 1.8 CONSTRUCTION SURVEYS

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 25 feet maximum and at all structures. Provide construction cut sheet preparation as required.

### 1.9 SPECIAL INSPECTIONS, TESTING OBSERVATION AND CERTIFICATIONS

A. ADDITIONAL INSPECTIONS, OBSERVATIONS AND CERTIFICATIONS: It shall be the responsibility of the contractor to hire the Engineer-of-Record to perform any additional special inspections, testing observations and certifications required beyond those specific services identified herein as being provided by the Owner.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. All materials shall be Frederick County Standards and shall meet all Frederick County requirements indicated.
- B. Polyvinyl Chloride (PVC) Pipe: ASTM D 3034, SDR 35 PVC gravity sewer pipe, size as indicated, standard manufacture laying length.
  - 1. Pipe Joints: ASTM D 3212 bell and spigot type, with flexible elastomeric gasket seals. Gaskets shall meet the requirements of ASTM F 477.
  - 2. Fittings shall be as indicated and required.
- C. Cleanouts:
  - 1. Cleanouts For Use in Paved Walk Areas: Refer to Section 33 41 00 "Storm Drainage", and as noted.
    - a. Expansion Joint: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.
  - 2. Furnish the owner with one cleanout wrench.

- D. Structures: Frederick County standards specified and indicated.
- E. Foundation and Bedding Materials: Refer to Section 33 10 00 "Utility Standards".
- F. Concrete: Refer to Section 33 10 00 "Utility Standards".
- G. Miscellaneous Products:
  - 1. Underground identification type manufactured by Allen Systems, Houston, Texas. "Detectatape" type, three inches wide, marked "Caution Sewer Line Buried Below", "Safety Green" color.

### PART 3 - EXECUTION

- 3.1 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH:
  - A. Refer to Section 33 10 00 "Utility Standards".
- 3.2 EXISTING SYSTEM CONNECTION:
  - A. Notify Frederick County no less than 48 hours prior to the start of system construction.
  - B. Excavate and expose existing pipe at connection location indicated. Adjust connection location, as required, in the event of conflicts with existing pipe joints. Neatly cut existing pipe and prepare cut end as required for connection with new pipe. Make connections with existing pipe using fittings designed for the purpose, in accordance with manufacturer's installation instructions.
- 3.3 PIPE:
  - A. General: Install in accordance with manufacturer's installation instructions and as noted. Inspect each pipe laying length and pipe joint materials for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Begin with installation at lowest system elevation and proceed up-grade. Field cut pipe only where required to complete structure-to-structure closures, install fittings or as specified. Cut pipe to smooth square end with equipment designed for cutting pipe.
  - B. Polyvinyl Chloride (PVC) Pipe: Install pipe in accordance with ASTM D 2321, manufacturer's installation instructions, and as noted.
    - Install with pipe spigot end pointing in flow direction. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed up-grade. Clean bell and spigot interior and exterior surfaces, removing oil, grit and foreign matter. Lubricate pipe ends and gasket in accordance with manufacturer's instructions. Position each laying length of previously installed pipe and manually push joint tightly together.
    - 2. Field Pipe Cutting: Shape spigot end of cut pipe to resemble manufactured spigot end, with a pipe-beveling tool designed for PVC pipe. Copy the full insertion mark provided on the manufactured spigot end onto the prepared field cut end.

# 3.4 EXISTING PIPE/STRUCTURE CONSTRUCTION

A. Excavate and expose existing pipe at structure location indicated. Adjust structure location as directed by the Architect or Owner's Representative in the event existing pipe joint interferes with structure walls, or as required to obtain required invert, at no increase to contract sum. Manually excavate below existing pipe prior to structure base placement. Place concrete structure base and construct structure as specified. Neatly cut and remove upper half of existing pipe and construct invert flow channel.

### 3.5 STRUCTURES

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. Pipe Connections: Install pipe opening sleeves in accordance with manufacturer's installation instructions. Neatly cut pipes flush with interior structure walls except as otherwise indicated or specified.
- C. Structure Joints: Apply liberal coat of joint coating material to each structure section joint in accordance with manufacturer's application instructions.
- D. Invert Flow Channels: Construct invert flow channels smooth and semicircular in shape. Shape channels with horizontal circular curve radii as large as structure will permit. Neatly form channels in structure base with bricks and cement mortar.

## 3.6 CLEANOUTS

- A. Refer to Section 33 41 00 "Storm Drainage", and as noted.
- B. Install cleanouts in accordance with manufacturer's installation instructions and as indicated.
  - 1. Construct concrete pads of Class "A" concrete as indicated.
  - 2. Cleanouts in paved walk shall be installed without a concrete pad. Top shall be cast into and set flush with finished walk surface.

# 3.7 BACKFILL

- A. Refer to Section 33 10 00 "Utility Standards", and as noted.
- B. Sanitary Sewer mains must be inspected by the Architect and Frederick County prior to completion of backfill operations. Contractor shall provide a minimum of 48 hours notice before completion of backfill operations.
- C. Underground Identification Tape: Install tape during backfill operations. Tape shall be centered over pipe, located 12 inches above top of pipe.

## 3.8 SYSTEM TESTING

A. Provide equipment, materials and labor required to test system. Conduct low pressure air tests in accordance with local jurisdiction approving agency standards. Provide a minimum of 48 hours notification of planned testing. Test observation by the Architect and Frederick County.

B. Repair or replace defective products and system construction, which fails tests as directed by local jurisdiction approving agency. Provide additional corrective work and retesting until system is approved and accepted. Provide corrective work and retesting at no increase to contract sum.

# 3.9 SYSTEM INSPECTION

- A. Retain the services of a Maryland-registered engineer for inspection of system construction and certification that system complies with standards specified. In accordance with the requirements on the approved drawings, the inspecting engineer must be the engineer of record for the approved drawings.
- B. Provide additional corrective work, determined necessary by television inspection, as specified for system testing.

# **END OF SECTION**

## SECTION 33 32 23 - BASE MOUNTED PUMPING SYSTEM

#### PART 1 - GENERAL

#### 1.1 SCOPE

- A. Contractor shall furnish and install one factory built base mounted, automatic pump station. The station shall be complete with all equipment specified herein, factory assembled on a common steel base.
- B. Principal items of equipment shall include two horizontal, self-priming, centrifugal sewage pumps, v-belt drives, motors, piping, valves, control panel, liquid level control system, and integral wiring.
- C. Factory built pump station design, including materials of construction, pump features, valves and piping, and motor controls shall be in accordance with requirements listed under PART 2 PRODUCTS of this section.
- D. Electrical power to be furnished to the site will be 3 phase, 60 hertz, 480 volts, maintained within plus or minus 10 percent. The available fault current provided at the pump station control panel is 42 kA rms symmetrical. Voltage tolerance shall be plus or minus 10 percent. Phase to phase unbalance shall not exceed 1% average voltage as set forth in NEMA Standard MG-1. Control voltage shall not exceed 132 volts.
- E. The pumping equipment shall be manufactured by The Gorman-Rupp Company, Mansfield, OH as supplied by Envirep, Inc., Camp Hill, PA (717-761-7884).

## 1.2 SUBMITTALS

- A. Product Data: Prior to fabrication, submit the following to the engineer for approval:
  - 1. Shop drawings providing layout of the mechanical equipment and anchor bolt locations, and indicating the use of Unified National Standard bolts and fasteners.
  - 2. Electrical ladder logic drawings illustrating motor branch and liquid level control circuits to extent necessary to validate function and integration of circuits to form a complete working system.
  - 3. Catalog cut sheets for major items of equipment, materials of construction, major dimensions, motor and v-belt drive data, pump characteristics curves showing design duty point capacity (GPM), head (FT), net positive suction head (NPSHR), and hydraulic brake horsepower.
  - 4. Pump Manufacturer's v-belt drive selection calculation summary sheet showing corrected H.P. Per Belt, total H.P. developed, pitch diameter of sheaves, center distance between driver and driven shafts and combined arc-length correction factor applied to theoretical horsepower transmission per v-belt, and all calculations to demonstrate a minimum Safety Factor of 1.5.
  - 5. Certified dimensional drawings indicating size, locations and the spherical solids passing capability of the primary recirculation port.
  - 6. Pre-startup checklist to be completed by the contractor prior to pre-startup inspection.
  - 7. Sample of service agreement and service agreement checklist for the specified equipment.
  - 8. Interconnection wiring diagram showing the field wiring between the telephone dialer and the alarms.
  - 9. Letter from pump manufacturer certifying that the pump(s), exclusive of the motor, base, drive, controls, or other associated components are constructed with cast iron, ductile iron, and steel that has been mined, melted, cast, machined, and assembled in the United States.
- B. Certified Tests: Prior to shipment of the equipment from the pump manufacturer's facility, submit the following certified tests to the engineer for approval.

- 1. Certified copies of factory run pump performance tests.
  - a. Tests shall be conducted in accordance with Hydraulic Institute Standards 14.6.3.4 Acceptance Grade 2B, or 14.6.3.4.1 for input power below 13 HP, at the specified head, capacity, rated speed and horsepower
  - b. The performance tests will validate the performance of the equipment at the design head, capacity and speed.
- 2. Certified reprime performance test data in accordance with procedures herein specified.
- 3. Tests shall be certified by a registered professional engineer.
- C. Certified System Performance Tests: All components, including the pumps, motors, and controls, will be tested as a complete working system at the pump manufacturer's facility. Tests shall be conducted in accordance with Hydraulic Institute Standards at the specified head, capacity, rated speed and horsepower. Factory operational tests shall simulate actual performance anticipated. Submit certified tests data to the engineer for approval.
- D. Operation and Maintenance Manuals:
  - 1. Operation shall be in accordance with written instructions provided by the pump system manufacturer. Comprehensive instructions supplied at the time of shipment shall enable personnel to properly operate and maintain all equipment supplied. Content and instructions shall assume operating personnel are familiar with pumps, motors, piping and valves, but lack experience on exact equipment supplied.
  - 2. Documentation shall be specific to the pumping equipment supplied and collated in functional sections. Each section shall combine to form a complete system manual covering all aspects of equipment supplied by the manufacturer. Support data for any equipment supplied by others, even if mounted or included in overall system design, shall be provided by those supplying the equipment. Instructions shall include the following as a minimum.
    - a. Functional description of each major component, complete with operating instructions
    - b. Instructions for operating pumps and pump controls in all modes of operation.
    - c. Calibration and adjustment of equipment for initial start-up, replacement of level control components, or as required for routine maintenance.
    - d. Support data for commercially available components not produced by the system manufacturer, but supplied in accordance with the specifications, shall be supported by literature from the prime manufacturer and incorporated as appendices.
    - e. Electrical schematic diagram of the pump control circuits shall be in accordance with branch, control, and alarm system circuits including interconnections. Wire numbers and legend symbols shall be shown. Schematic diagrams for individual components, not normally repairable by the system operator, need not be included. Details for such parts shall not be substituted for an overall system schematic. Partial schematics, block diagrams, and simplified schematics shall not be provided in lieu of overall system diagram.
    - f. Mechanical layout drawing of the pumping equipment and components, prepared in accordance with good commercial practice, shall provide installation dimensions and location of all pumps, motors, valves and piping.
  - 3. Operation and maintenance instructions, which rely on vendor cut-sheets and literature, which include general configurations, or require operating personnel to selectively read portions of a manual shall not be acceptable. Operation and maintenance instructions must be specific to equipment supplied in accordance with these specifications.
  - 4. Telephone dialer instructions and interconnection wiring diagram showing the field wiring between the telephone dialer and the alarms.

- E. Manufacturer's Field Performance Test Report: The manufacturer's technical representative shall inspect the completed installation, correct or supervise the correction of any defect or malfunction, instruct operating personnel in the proper operation and maintenance of the equipment. A written report covering the equipment startup shall be mailed from the manufacturer's startup technician directly to the owner. At a minimum, the report shall include:
  - 1. Nameplate information.
  - 2. Recordings of gauge readings, static discharge head, and total dynamic head for each pump.
  - 3. Recordings of operating speed for each pump, measured with a tachometer.
  - 4. Recordings of level control settings
  - 5. Certification that equipment has been properly installed and lubricated and is in accurate alignment.
  - 6. Certification that the v-belt drive system has been properly aligned using a laser alignment instrument and that v-belts have been tensioned using a belt tensioning instrument.
  - 7. Results of electrical test include voltage readings and amperage readings of all motors.
  - 8. Certification that the equipment has been operated fully loaded and that it operated satisfactorily.
  - 9. Outline in detail any deficiencies noted, and proposed remedial corrections.
  - 10. Confirm proper installation and operation of telephone dialer including actual tripping of each alarm input device, telephone reception, message programming, call out list, proper wiring, and instruction of operating personnel.
  - 11. Confirm that all spare parts are on site. Include photographs of spare parts in startup report
  - 12. Include the following photographs in the startup report:
    - a. Overall pump station job site
    - b. Pumps and motors
    - c. Discharge header piping
    - d. Pump control panel closed door
    - e. Pump control panel open door
    - f. Wet well

### 1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Upon request from the engineer, the pumping equipment manufacturer shall demonstrate the following:
  - 1. Proof of financial stability and ability to produce the pumping equipment within the specified delivery schedules.
  - 2. Evidence of the facilities, equipment, and expertise to demonstrate the manufacturer's commitment to long-term customer service and project support.
  - 3. Evidence of adequate local and factory spare parts inventory to provide timely delivery of spare parts
  - 4. Evidence that the pump manufacturer is an Underwriters Laboratories (UL) panel builder.
  - 5. Evidence that the pumps and pumping equipment are constructed, assembled and tested in the United States by the pump manufacturer. All pump parts including the casing shall be machined at the pump manufacturer's facility located within the United States.
  - 6. To ensure compatibility to existing tools and equipment, all pump internal and external nuts, bolts, and hardware, shall be Unified Thread Standard (UNC) per ASME/ANSI standards.
  - 7. Consideration will be given only to pump manufacturer's meeting the following qualifications:

- a. Twenty-five years minimum experience successfully producing pumping equipment of the type specified herein.
- b. A minimum of twenty-five installations of pumping equipment of the type specified herein in successful operation for a minimum of ten years
- 8. Pump manufacturer must be ISO 9001:2000 certified, with scope of registration including design control and after sales activities.
- B. Manufacturer's Representative Qualifications: Upon request from the engineer, the equipment manufacturer's local representative shall demonstrate the following:
  - 1. Evidence of adequate local spare parts inventory to provide timely delivery of spare parts.
  - 2. Evidence of established locally based factory-trained service personnel.
  - 3. Evidence that representative offers comprehensive equipment service agreements for the equipment specified.
  - 4. List of at least ten local municipalities with installations similar to the specified equipment.
  - 5. Evidence that the representative offers full-day operator training seminars on Centrifugal Pump Maintenance and Troubleshooting.
  - 6. Evidence that the representative offers technical design assistance and hydraulic recommendations for pump station design.
  - 7. Certification from manufacturer that the service technician has been factory-trained and is authorized for such duties by the manufacturer.
- C. Pump Performance:
  - 1. Design and construct the pumps in accordance with standards of the Hydraulic Institute. The efficiency of the pumps, when operating under conditions of the specified capacities and heads shall be as near peak efficiency as practicable.
  - 2. Design the pumps designated as self-priming centrifugal to pump raw sewage containing solids up to ten percent and stringy materials with a minimum of clogging. Pumps may be protected by screening equipment, but materials passing through may combine by a felting or balling process.
- D. Source Quality Control:
  - 1. Obtain pumping equipment, motors, motor starters, pump controls and appurtenances from the pump manufacturer whose responsibility it is to ensure that the pumping equipment is properly furnished, coordinated, and tested in accordance with these specifications. The products of third party packagers, assemblers or distributors shall neither be considered equal, not shall they be acceptable.
  - 2. The pump control panel including the level controls shall be constructed at the pump manufacturer's facilities. The pump manufacturer shall be an Underwriters Laboratories (UL) panel builder. The control panel shall meet all UL and Joint Industrial Council (JIC) standards.

# 1.4 MANUFACTURER'S WARRANTY

- A. All components of the pumping equipment shall be manufactured, assembled and tested as a unit by the pump manufacturer. The pumping equipment must be a standard catalog item with the manufacturer. The pump manufacturer must assume system responsibility, i.e. the pumping equipment must be warranted by the manufacturer as described herein. Individual component warranties are desirable. However, individual warranties honored solely by the manufacturers of each component will not be acceptable.
- B. The pump manufacturer shall warrant all equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

- 1. All equipment, apparatus, and parts furnished shall be warranted for one (1) year, excepting only those items that are normally consumed in service, such as light bulbs, oils, grease, packing, gaskets, O-rings, etc. The pump manufacturer shall be solely responsible for warranty of the pumping equipment components when installation is made and use and maintenance is performed in accordance with the manufacturer's recommendation.
- 2. The pump shall be warranted for five (5) years from date of shipment.
- 3. Components failing to perform as specified by the engineer, or as represented by the manufacturer, or as proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts to the owner.
- C. It is not intended that the pump manufacturer assume liability for consequential damages or contingent liabilities arising from failure of any vendor supplied product or part which fails to properly operate, however caused. Consequential damages resulting from defects in design, or delays in delivery are also beyond the manufacturer's scope of liability.
- D. The warranty shall become effective upon the acceptance by the purchaser or the purchaser's authorized agent, or sixty (60) days after installation, or ninety (90) days after shipment, whichever occurs first.

### 1.5 MANUFACTURER

- A. These specifications and accompanying drawings specify and show equipment and materials manufactured by The Gorman-Rupp Company, deemed most suitable for the service anticipated. The contractor shall prepare his bid on the basis of the particular equipment and materials specified for the purpose of determining the low bid. The awarding of the contract shall constitute a contractual obligation to furnish the specified equipment and materials.
- B. After execution of the contract, the contractor may request to substitute equipment other than that specified in the contract. Substitutions will only be considered in the event that the equipment proposed for substitution is superior in construction and efficiency to that specified in the contract, and higher quality has been demonstrated by service in a sufficient number of similar installations.
- C. In the event the contractor obtains engineer's approval of equipment other than that for which the system was originally designed, the contractor shall, at his own expense, make any changes in the structures, buildings or piping necessary to accommodate the equipment, and shall provide as-built drawings to the engineer.
- D. It will be assumed that the cost to the contractor of the equipment proposed to be substituted is less than that of the equipment specified in the contract and, if substitution is approved, the contract price shall be reduced by an amount equal to the savings.

# PART 2 - PRODUCTS

# 2.1 PUMPS

- A. Pump Description:
  - 1. Pumps shall be Gorman-Rupp Model T3A71S-B horizontal, self-priming, centrifugal pumps, specifically designed for pumping raw, unscreened, domestic sanitary sewage.
  - 2. All openings, internal passages, and internal recirculation ports shall be large enough to permit the passage of the specified spherical solids passing capacity, and any trash or stringy material which may pass through the average house collection system. Screens or any internal devices that create a maintenance nuisance or interfere with priming and performance of the pump shall not be permitted.
  - 3. The pumps shall have the following characteristics:

a.	Suction connection, flanged, in	3
b.	Discharge connection, flanged, in	3
c.	Minimum shutoff head, each pump, ft	41
d.	Pump speed, rpm	1200
е.	Maximum NPSH required at design point, ft	4.0
f.	Minimum reprime lift capability, ft	16
g.	Spherical solids passing capability, in. diameter	2.5
h.	Motor horsepower	5
i.	Motor speed, rpm	1750
j.	Impeller diameter, in	8-3/4

### B. Pump Performance:

1. Each pump must have the necessary characteristics and be properly selected to perform under these operating conditions:

a.	Capacity, gpm	125
b.	Total dynamic head, ft	34
c.	Total dynamic suction lift, ft	16.5
d.	Maximum static suction lift, ft	14.1
e.	Discharge static head, ft	3.6

- 2. Consideration shall be given to the sanitary sewage service anticipated, in which occasionally debris will lodge between the pump suction check valve and seat, resulting not only in loss of the suction leg, but also in the siphoning of liquid from the pump casing to the approximate center line of the impeller. Such occurrence shall be considered normal with proper installation of air release line to atmosphere.
- 3. In consideration of such occurrence and of the unattended operation anticipated, each pump shall be so designed as to retain adequate liquid in the pump casing to insure unattended automatic repriming while operating at its rated speed in a completely open system without suction check valves and with a dry suction leg.

### C. Reprime Performance:

- 1. Each pump must be capable of the specified reprime lift while operating at the selected speed and impeller diameter. Reprime lift is defined as the static height of pump suction centerline above liquid that the pump will prime; and delivery within five minutes on liquid remaining in the pump casing after a delivering pump is shut down with the suction check valve removed. Systems requiring ancillary vacuum generating devices shall not be acceptable. Additional standards under which reprime tests shall be run are:
  - a. Piping shall incorporate a discharge check valve down stream from the pump. Check valve size shall be equal (or greater than) the pump discharge diameter.
  - b. A ten-foot length of one-inch pipe shall be installed between pump and discharge check valve. This line shall be open to atmosphere at all times to duplicate the air displacement rate of a typical pump system fitted with an air release valve.
  - c. No restrictions shall be present in pump or suction piping that could serve to restrict the rate of siphon drop of the suction leg. Suction pipe configuration for reprime test shall incorporate a minimum horizontal run of 2 feet and one 90-degree elbow.
  - d. The pipe size used for the reprime performance test shall be the same size as the pump suction diameter.

- e. Impeller shall be set at the clearances recommended by the manufacturer in the pump service manual.
- f. Reprime lift repeatability shall be demonstrated by five sequential reprime cycles.
- g. Liquid to be used for reprime test shall be water.
- D. Serviceability:
  - 1. The pump manufacturer shall demonstrate to the engineer's satisfaction that due consideration has been given to reducing maintenance costs by incorporating the following features:
    - a. No special tools shall be required for replacement of any components within the pump. Threaded fasteners shall be of the Unified National Standard type.
    - b. The mechanical seal shall be a one-piece cartridge type to allow for easy replacement. Mechanical seals requiring assembly of individual components shall not be acceptable.
    - c. The pump must be equipped with a removable cover plate, allowing access for service and repair without removing suction or discharge piping.
    - d. The pump shall be fitted with a replaceable wear plate. Replacement of the wear plate, impeller, seal, and suction check valve shall be accomplished through the removable cover plate without removing suction or discharge piping.
    - e. The entire rotating assembly, which includes bearings, shaft, seal, and impeller, shall be removable as a unit without removing the pump volute or piping.
    - f. Each pump shall incorporate a suction flap valve that can be removed or installed through the removable cover plate opening, without disturbing the suction piping. Sole function of the suction flap valve shall be to eliminate re-priming with each cycle. Pumps requiring suction flap valves to prime or reprime will not be acceptable.
    - g. Atmospheric isolation: The shaft bearings shall be isolated from the seal cavity with an air gap to provide positive protection of the bearings in the event of a seal leak and to provide for external monitoring of the seal integrity.
    - h. Adjustment of the impeller face clearance (distance between impeller and wear plate) shall be accomplished by external means. The adjusting mechanism shall provide a means to make discrete calibrated movements in increments of 0.005 inches. No special tools, measuring devices, feeler gauges, or other tools shall be required to make these impeller-to-wear plate clearance adjustments.
    - i. Clearances between the impeller and wear plate shall be maintained by a 4 point external shimless coverplate adjustment system with four collar and adjusting screws. Provide 4-point incremental clearance adjustment. Each of the 4 points shall be lockable to prevent inadvertent clearance increases or decreases due to equipment vibration. The 4 point system shall provide equal clearance gaps at all points between the impeller and wear plate. Systems that require realignment of belts, couplings, sheaves, etc., each time a clearance adjustment is performed shall not be acceptable. Coverplate shall be capable of being removed and reinstalled without disturbing the clearance settings. Clearance adjustment systems that utilize less than 4 point system will not be considered.
    - j. There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the coverplate side of the pump. The removal of stainless steel shims from the rotating assembly side of the pump shall allow for further adjustment as described above.
    - k. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.
- E. Construction:

- 1. The pump, excluding the base frame and motor, shall be manufactured of iron that is melted and cast in the United States.
- 2. Pump design: Pumps shall be the original design of the pump manufacturer. Products violating intellectual property regulations shall not be allowed, as they may violate domestic or international law and expose the user or engineer to unintended liabilities. Reverse-engineered products fabricated to imitate the design of original products shall not be allowed as they may contain substantial differences in tolerances and material applications that may contribute to product failure.
- 3. Hardware: All hardware, nuts and bolts, shall be Unified Thread Standard (UNC) per ASME/ANSI standards.
- 4. Pump casing: Made of Gray Iron 30, shall be foot supported, and shall have a horizontal centerline suction and vertical discharge.
  - a. The casing shall have a top mounted 3-1/2 inch priming fill port with a safety lock bar cover. In consideration for safety, hand nut threads must provide slow release of pressure, and the clamp bar shall be retained by detent lugs. A Teflon gasket shall prevent adhesion of the fill port cover to the casing.
  - b. Casing shall have no openings of smaller diameter than the specified sphere size.
  - c. Casing shall be designed to retain sufficient liquid to ensure automatic repriming and unattended operation.
  - d. A minimum 1-1/4 inch diameter drain hole shall be provided for attachment of the pump drain kit and to ensure complete and rapid draining.
  - e. Bolts and other threaded fasteners shall have Unified National Standard threads.
  - f. Suction flap valve: Molded neoprene with integral steel and nylon reinforcement. A blow-out center shall protect the pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished through the cover plate opening without disturbing the suction piping. Sole function of the suction flap valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.
  - g. Pump shall be provided with a separate capped threaded port for use of an optional casing heater.
- 5. Cover plate: Cover plate shall be Gray Iron 30.
  - a. Retained by four (4) hand nuts for complete access to pump interior. Cover plate removal must provide ample clearance for removal of stoppages, and the allow removal or service to the impeller, seal, wear plate or suction flap valve.
  - b. Replaceable wear plate (ADI): Secured to the cover plate by four (4) welded studs and nuts. The wear plate shall be cast in Austempered Ductile Iron or hardened steel with a minimum Brinell Hardness of 400. The wear plate shall be of sufficient width to maintain the manufacturer's recommended clearance between the entire edge of each impeller vane and the wear plate. Wear plate attachment hardware shall have Unified National Standard threads and shall be located out of the direct flow path of the liquid into the impeller. Two (2) Buna-N o-rings shall seal cover plate to the pump casing.
  - c. O-ring Seals: Two (2) Buna-N o-rings shall seal cover plate to the pump casing. The inner cover plate o-rings shall provide a seal between the suction chamber and the discharge chamber of the pump casing to eliminate the possibility of recirculation at the wear plate.
  - d. In consideration for safety, a pressure relief valve shall be supplied in the cover plate. Relief valve shall open at 75 PSI.

- e. Pusher bolt capability to assist in removal of coverplate. Threaded pusher boltholes shall be sized to accept same retaining capscrews as used in rotating assembly.
- f. Easy-grip handle shall be mounted to face of coverplate.
- 6. Rotating assembly:
  - a. Impeller (ADI): Two-vaned, semi-open, non-clog, cast in Austempered Ductile Iron with a minimum Brinell Hardness of 400 with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lockscrew.
  - b. Shaft: Shaft shall be constructed of Alloy Steel No. 4150 and shall employ an Alloy Steel No. 4130 shaft sleeve.
  - c. Mechanical seal: A mechanical cartridge seal shall seal the pump shaft against leakage. The stationary sealing member and the mated rotating face shall be silicon carbide. Each of the mated surfaces shall be lapped to a flatness of three light bands (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat shall be double floating so that faces will not lose alignment during periods of shock loads that will cause deflection, vibration, and axial movement of the pump shaft. The seal shall be warranted for five (5) years from date of shipment.
  - d. Lubrication: Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Oil cavities must be cooled by the liquid pumped. Three lip seals will prevent leakage of oil.
    - 1) The bearing cavity shall have an oil level sight gauge and fill plug with check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.
    - 2) The seal cavity shall have an oil level sight gauge and fill plug with vent. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the vented fill plug.
    - 3) Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.
  - e. Atmospheric isolation: The shaft bearings shall be isolated from the seal cavity with an air gap to provide positive protection of the bearings in the event of a seal leak and to provide for external monitoring of the seal integrity.
  - f. Seal plate (ADI): Replaceable seal plate shall be constructed of Austempered Ductile Iron with a minimum Brinell Hardness of 400, and shall be bolted to the bearing housing.
  - g. Shaft bearings: Shall be anti-friction ball bearings, of ample size and proper design to withstand all radial and thrust loads which can reasonably be expected during normal operation. Pump designs in which the same oil lubricates both the shaft bearings and the shaft seal shall not be acceptable.
  - h. Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same capscrews as used for retaining rotating assembly.
- 7. Suction and discharge spools: Each pump shall be equipped with one-piece, cast iron spools, flanged on each end. Each spool shall have one 1 1/4-inch NPT and one 1/4-inch NPT tapped hole with pipe plugs for mounting of gauges or other instrumentation.

# 2.2 PUMP ACCESSORIES

- A. Spare Parts: Furnished the following spare parts:
  - 1. Two (2) Spare Parts Kits, each including one (1) mechanical cartridge seal, one (1) set of rotating assembly adjustment shims, one (1) cover plate o-ring, one (1) rotating assembly o-ring

- 2. One (1) complete rotating assembly (with austempered ductile iron impeller and seal plate)
- 3. One (1) wear plate (hardened) with attachment hardware
- 4. Four (4) suction flap valve assemblies
- 5. One (1) belt tensioning gauge spring loaded
- 6. Two (2) quarts of seal lubricant
- 7. One (1) air pump for bubbler level control system
- 8. Two (2) air pump repair kits for bubbler level control system
- 9. Two (2) air pump connector rod kits for bubbler level control system
- 10. Two (2) air pump inline check valves
- 11. Two (2) air release valve diaphragms
- 12. Two (2) air release valve springs
- 13. One (1) ARV spring compression tool
- 14. One (1) gallon touch-up paint, white
- 15. One (1) quart touch-up paint, safety orange
- B. Gauge Kit With Vibration Isolation Frame:
  - Each pump shall be equipped with a glycerin-filled compound gauge to monitor suction pressures, and a glycerin-filled pressure gauge to monitor discharge pressures. Gauges shall be a minimum of 4-inches in diameter, and shall be graduated in feet water column. Rated accuracy shall be 1 percent of full-scale reading. Compound gauges shall be graduated -34 feet to +34 feet water column minimum. Pressure gauges shall be graduated 0 to 70 feet water column minimum.
  - 2. Gauges shall be mounted on a vibration isolation frame assembly with resilient panel, frame, and adjustable brackets which shall be firmly secured to pumps or piping. Gauge installations shall be complete with all hoses and fittings, and shall include a shutoff valve installed in each gauge inlet at the point of connection to suction and discharge pipes.
  - 3. Gauge kit shall be supplied with stainless steel fittings.
- C. Pump Drain Kit:
  - 1. A pump drain kit shall be provided, including the following:
    - a. One set of drain fittings for each pump. Each set of drain fittings includes a pipe nipple, bushing, bronze ball valve and aluminum quick connect male Kamlock fitting.
    - b. One drain hose for common use among all pumps. Drain hose shall consist of a 10' length of plastic hose with an aluminum quick connect female Kamlock fitting on one end.
  - 2. All fittings shall be supplied as stainless steel, unless specified otherwise above.

# 2.3 VALVES AND PIPING

- A. Check Valves, 4-inch:
  - 1. Each pump shall be equipped with a full flow type check valve, each capable of passing a 3" spherical solid, with flanged ends and be fitted with an external lever and spring. The valve seat shall be constructed of stainless steel and shall be replaceable. The valve body shall be cast iron. The valve shall be equipped with a removable cover plate to permit entry for complete removal and replacement of internal components without removing the valve from the line. Valve clapper shall have a molded neoprene seating surface incorporating low pressure sealing rings. Valve hinge pin and internal hinge arm shall be stainless steel supported on each end in brass bushings, sealing bushing shall have double o-rings. O-rings shall be easily replaceable without requiring access to interior of valve body. Valve shall be rated at 175-PSI water working pressure, 350-PSI hydrostatic test

pressure. Valves other than full flow type or valves mounted in such a manner that prevents the passage of a 3" spherical solid shall not be acceptable.

- 2. Each check valve shall be provided with a <sup>1</sup>/<sub>4</sub>-inch treaded tap with plug on the downstream side of the valve for installation of a pressure gauge.
- B. Plug Valves, 4-inch:
  - 1. Each pump shall be equipped with a full flow type plug valve, capable of passing a 3" spherical solid, with flanged ends and be fitted with a lever operator to permit the pump to be isolated from the common discharge header. The plug valve shall be non-lubricated, tapered type. Valve body shall be semi-steel with flanged end connections drilled to 125 pound standard. The drip-tight shutoff plug shall be mounted in stainless steel bearings and shall have a resilient facing bonded to the sealing surface. Valve shall be operated with a single lever actuator providing lift, turn, and reseat action. The lever shall have a locking device to hold the plug in the desired position.
- C. Air Release Valves (Diaphragm Type):
  - 1. Each pump shall be equipped with one pressure actuated automatic air release valve, designed to permit the escape of air to the atmosphere during initial priming or unattended repriming cycles. Upon completion of the priming or repriming cycle, the valve shall close to prevent recirculation. Valves shall provide visible indication of valve closure, and shall operate solely on discharge pressure. Level/float actuated air release valves shall not be acceptable.
  - 2. All valve parts exposed to sewage shall be constructed of cast iron, stainless steel, or similar corrosion resistant materials. Diaphragms shall be fabric-reinforced neoprene or similar inert material.
  - 3. A cleanout port, 3 inches or larger in diameter, shall be provided for ease of inspection, cleanout, and service.
  - 4. Valves shall be field adjustable for varying discharge heads.
  - 5. Air release valves shall be connected to pump station piping using stainless steel pipe fittings.
  - 6. Each air release valve shall be provided with an isolation ball valve.
  - 7. Air release valve piping must discharge directly into wet well. ARV piping shall not discharge to a sump.
  - 8. Each air release valve shall have a separate air release discharge pipe back to the wet well for each air release valve. Discharge pipe shall be minimum 1-½-inch diameter.
- D. Header Piping:
  - 1. Flanged header pipe shall be centrifugally cast, ductile iron, complying with ANSI/AWWA A21.51/C115 and Class 53 thickness. Flanges shall be cast iron Class 125 and comply with ANSI B16.1. All piping pipe and flanges shall be threaded and suitable thread sealant applied before assembling flange to pipe.
  - 2. Boltholes shall be in angular alignment within <sup>1</sup>/<sub>2</sub>-degree between flanges. Flanges shall be faced and a gasket finish applied that shall have concentric grooves a minimum of 0.01 inch deep by approximately 0.03 inch wide, with a minimum of three grooves on any given surface spaced a maximum of <sup>1</sup>/<sub>4</sub> inch apart.
- E. Supports and Thrust Blocks:
  - 1. Contractor must insure all pipes connected to the pumping system are supported to prevent piping loads from being transmitted to pumps or system piping.
  - 2. Pump station discharge force main piping shall be anchored with thrust blocks by the contractor where shown on the contract drawings.
- F. Gauge Connection Assembly:

- 1. The header piping shall be equipped with a gauge connection assembly located between the discharge check valve and force main isolation plug valve allowing the operator to easily attach a discharge gauge on any pump for troubleshooting.
- 2. The gauge assembly shall consist of a 1/4" brass pipe nipple, 1/4" brass full port ball valve and a quick connect fitting.
- 3. The gauge connection assembly shall be installed in the discharge header piping such that the static and dynamic pressure in the force main can be read at all times unless the force main isolation plug valve is closed for that particular pump.

# 2.4 FABRICATED STEEL BASE

A. One fabricated steel base shall be provided for the duplex pump and motor assembly. The base shall comprise a base plate, perimeter flange, and reinforcements. Base plate shall be fabricated of steel not less than <sup>1</sup>/<sub>4</sub>" thick, and shall incorporate openings for access to all internal cavities to permit complete grouting of unit base after installation. Perimeter flange and reinforcements shall be designed to prevent flexing or warping under operating conditions. Base plate and/or flange shall be drilled for hardware used to secure unit base to concrete pad as shown on the contract drawings. Unit base shall contain provisions for lifting the complete pump unit during shipping and installation.

# 2.5 DRIVE UNIT

- A. Motors:
  - 1. Provide motors as specified herein. Any additional motor requirements specified in another Specification Section, but not specified herein, shall not apply to the motors for this equipment.
  - 2. The pump motors shall be horizontal, totally enclosed fan cooled, induction type, with normal starting torque and low starting current characteristics.
  - 3. The motors shall not be overloaded at the design condition or at any head in the operating range as specified.
  - 4. Motors shall be tested in accordance with provisions of ANSI/IEEE Std. 112.
  - 5. Each motor shall be in current NEMA design B cast iron frame with copper windings.
  - 6. Motors shall be NEMA Premium Efficient, per NEMA MG-1, Table 12-12.
- B. Drive Transmission:
  - 1. Power shall be transmitted from motors to pumps by means of v-belt drive assemblies. The drive assemblies must be selected to establish proper pump speed to meet the specified operating conditions.
  - 2. Each drive assembly shall have a minimum of two v-belts. In no case will a single belt drive be acceptable. Each v-belt drive assembly shall be selected on the basis that adequate power will be transmitted from driver to pump. Drive systems with a safety factor of less than 1.5 shall not be considered sufficient for the service intended. Computation of safety factors shall be based on performance data published by the drive manufacturer.
  - 3. V-belts shall be the banded type.
- C. Belt Guards:
  - 1. Pump drive transmissions shall be enclosed on all sides in a guard constructed of any one or combination of materials consisting of expanded, perforated, or solid sheet metal, except that maximum perforated or expanded openings shall not exceed <sup>1</sup>/<sub>2</sub> inch.
  - 2. Guards shall be manufactured to permit complete removal from the pump unit without interference with any unit component, and shall be securely fastened to the unit base.

- 3. All metal shall be free of burrs and sharp edges. Structural joints shall be continuously welded. Panels may be riveted to frames with not more than five-inch spacing. Tack welds shall not exceed four-inch spacing.
- 4. The guard shall be finished with one coat of gray W.R. non-lift primer and one coat of orange acrylic alkyd W.R. enamel in accordance with section 3, Color Definitions of ANSI 253.1; Safety Color Code for Marking Physical Hazards.

# 2.6 FINISH

- A. Surface Preparation and Painting:
  - 1. Pumps, piping, and exposed steel framework shall be cleaned prior to coating, using an approved solvent wipe or phosphatizing cleaner. The part must thoroughly dry before pain application. Open joints shall be caulked with an approved polyurethane sealant.
  - 2. Exposed surfaces to be coated with one coat of Tnemec Series 69 Polymide Epoxy primer and one finish coat of Series 73 Aliphatic Acrylic Polyurethane for a total dry film thickness of 4-6 mils. Finish coat shall be semi-gloss white for optimum illumination and enhancement.
  - 3. The finish coat shall be corrosion, moisture, oil, and solvent resistant when completely dry.
  - 4. The factory finish shall allow for over-coating and touch up for 6 months after coating. Thereafter, sanding may be required to accept a topcoat or touch-up coating.

# 2.7 PUMP CONTROL SYSTEM

- A. General:
  - 1. This specification covers a pump control system for the duplex pumping system including motor circuit breakers, starters, thermal overload relays, door mounted operator controls, and liquid level controls.
  - 2. The liquid level control will include an air bubbler level control system, electronic pressure switch, pump sequence control, alarms and pump safety shutdowns.
- B. UL Listing:
  - 1. The pump controls shall be manufactured by the pump manufacturer who shall be a UL panel builder and each assembly shall bear a serialized UL label listed for "Enclosed Industrial Control Panels."
  - 2. The enclosure and all components mounted on the sub-panel or control cover shall conform to UL descriptions and procedures. Listing for open style industrial control panels or an assembly of listed or recognized components shall not be acceptable.
- C. Panel Enclosure:
  - 1. Enclosure shall be constructed in conformance with applicable section of national electrical manufacturers' association (NEMA) standards for Type 1 electrical enclosures. Enclosure shall be fabricated of stainless steel having a minimum thickness of not less than 0.075 inch (14 gauge).
  - 2. Door shall be hinged and sealed with a neoprene gasket and shall be held closed with clamps that are quick and easy to operate. The door shall accommodate the mounting of switches and indicators.
  - 3. Enclosure shall be furnished with a removable back panel, fabricated of steel having a thickness of not less than 0.106 inch (12 gauge), which shall be secured to the enclosure with collar studs. Such panel shall be of adequate size to accommodate all basic components.
  - 4. All control components shall be securely fastened to a removable back panel with screws and lock washers. Switches, indicators and instruments shall be mounted through the control panel door. Self--tapping screws shall not be used to mount any components.

- 5. Each control assembly shall be furnished with main terminals and ground lug for field connection of the electrical supply. The connections shall be designed to accept copper conductors of sufficient size to serve the loads. The main terminals shall be mounted to allow incoming wire bending space in accordance with article 373 of the National Electric Code (NEC). A separate terminal strip shall be provided for 115 volt, single-phase control power and shall be segregated from the main terminals. Ten percent of the control terminals shall be furnished as spares.
- D. Motor Branch Components:
  - All motor branch components shall be of the highest industrial quality. Operating coils of all AC control devices shall be rated for 120 volts, and shall be suitable for use in a voltage range of 108 to 132 volts, 60 hertz. The short circuit rating of all power circuit devices shall be a tested combination or evaluated per the National Electric Code Article 409. The lowest rated power circuit component shall be the overall control panel short circuit rating and shall not be less than the fault current available. The minimum control panel rating shall not be less than 10 kA, rms symmetrical. Control assemblies operating at 120 volts nominal or less may be provided with transformers which limit that fault current and may be rated less than the minimum required short circuit rating.
  - 2. Circuit Breakers and Operating Mechanisms:
    - a. A properly sized heavy duty air circuit breaker shall be furnished for each pump motor. All circuit breakers shall be sealed by the manufacturer after calibration to prevent tampering.
    - b. A padlocking operating mechanism shall be installed on each motor circuit breaker. Operator handles for the mechanisms shall be located on the exterior of the control compartment door, with interlocks which permit the door to be opened only when circuit breakers are in the "off" position.
  - 3. Motor Starters:
    - a. An open frame, across-the-line, NEMA rated magnetic motor starter shall be furnished for each pump motor. Starters of NEMA size 1 and above shall be designed for addition of at least two auxiliary contacts. Starters rated "0", "00", or fractional sizes shall not be acceptable. Power contacts shall be double-break and made of cadmium oxide silver. All motor starters shall be equipped to provide undervoltage release and overload protection on all three phases.
    - b. Motor starter contacts shall be easily replaceable without removing the motor starter from its mounted position.
  - 4. Overload Relays:
    - a. Overload relays shall be of the thermal block-type and shall have visual trip indication with trip-free operation. Pressing of the overload reset lever shall not actuate the control contact until such time as the overload thermal element is reset. Resetting of the overload reset lever will cause a snap-action control contact to reset, thus re-establishing a control circuit.
    - b. Overload reset pushbuttons shall be mounted through the door of the control panel in such a manner as to permit resetting the overload relays without opening the control panel door.
- E. Indicators:
  - 1. Physical indicating light operators shall be made of an industrial grade thermoplastic and chemical-resistant for harsh environments. Lights shall have a protection rating of IP 65/66 (type 3/3R/4/4X/12/13). Lights shall include an easily replaceable, integrated LED power module for long lamp life. Indicating lights shall be push-to-test.
  - 2. Indicating lights will be furnished for the following functions:
    - a. General alarm (Integrinex) Red

- b. Pump No. 1 run Green
- c. Pump No. 2 run Green
- d. Pump Fault, No. 1 Red
- e. Pump Fault, No. 2 Red
- f. High Water Alarm Red
- F. Switch Controls:
  - 1. A normal duty thermal-magnetic circuit breaker shall protect all control circuits by interrupting control power.
  - 2. Pump mode selector switches shall be connected to permit manual start and manual stop of each pump individually or permit automatic operation under control of the liquid level control system. Manual operation shall override shutdown systems except motor overload and phase failure relays. Selector switches shall be oil-tight design with contacts rated NEMA A-300.
  - 3. Override switches shall be connected to bypass the level control system and all shutdown systems supplied with it, to provide manual start and manual stop of each pump individually in the event of level control system malfunction.
  - 4. A selector switch shall provide manual alternation of the air pumps in the bubbler system. The switch shall be connected in such a manner that either pump may be selected to operate continuously.
  - 5. A pushbutton switch shall be provided to silence the 115-volt AC alarm circuits while corrective actions are underway. Depressing the alarm silence pushbutton shall also cause the high water alarm circuit to reset when the liquid level has been lowered.
- G. High Pump Temperature Shutdown:
  - 1. The control panel shall be equipped with circuitry to override the level control system and shut down the pump motor(s) when required to protect the pump from damage caused by excessive temperature.
  - 2. A thermostat shall be mounted on each pump to detect its temperature. If the pump temperature should rise to a level that could cause pump damage, the thermostat shall cause the pump motor to shut down. A visual mechanical indicator shall indicate that the pump motor has been stopped because of a high temperature condition.
  - 3. The pump shall remain locked out until the pump has cooled and the circuit has been manually reset. Automatic reset of such a circuit shall not be acceptable.
- H. Elapsed Time Meters:
  - 1. Six-digit elapsed time meters (non-reset type) shall be connected to each motor starter to indicate the total running time of each pump in "hours" and "tenths of hours".
- I. Pump Start Delay:
  - 1. The lag pump will be equipped with a time delay to prevent simultaneous motor starts.
- J. Alarm Contacts:
  - 1. Provide separate alarm contacts for the following alarm conditions:
    - a. High water
    - b. Phase failure
    - c. Pump fault, #1
    - d. Pump fault, #2
    - e. Station low temperature
    - f. Pump run, #1 normally open
    - g. Pump run, #2 normally open
- K. Three Phase Voltage Monitor:

- 1. The control panel shall be equipped to monitor the incoming power and shut down the pump when required to protect the motor(s) from damage caused by phase-reversal, phase loss and voltage. The motor(s) shall automatically restart when power conditions return to normal.
- L. Secondary Surge Arrestor:
  - 1. The control panel shall be equipped with a surge arrestor to minimize damage to the pump motors and control from transient voltage surges. The arrestor shall utilize metal-oxide varistors encapsulated in a non-conductive housing. The arrestor shall have a current rating of 60,000 Amps and a Joule rating of 1,500.
- M. Receptacle:
  - 1. A duplex ground fault interrupter utility receptacle providing 115 VAC, 60 hertz, singlephase current shall be provided. Receptacle circuit shall be protected by a 15-ampere thermal-magnetic circuit breaker.
- N. Auxiliary Power Transformer:
  - 1. A 3 KVA step-down transformer shall be provided to supply 115 volt, AC, single phase for the control and auxiliary circuits. The primary side of the transformer shall be protected by a thermal-magnetic air circuit breaker, specifically sized to meet the power requirements of the transformer. A mechanical operating mechanism shall be installed on the circuit breaker to provide a means of disconnecting power to the transformer.
  - 2. A padlockable operator handle for the operating mechanism shall be located on the exterior of the control panel with interlocks which prevent opening the door until primary circuit breaker is in the "OFF" position.

# 2.8 WIRING

- A. General:
  - 1. The pump control as furnished by the manufacturer shall be completely wired except for the power feeder lines to the branch circuit breakers and final connections to remote alarm devices and between control assemblies.
  - 2. All wiring, workmanship, and schematic wiring diagrams shall be in compliance with applicable standards and specifications set forth by the National Electric Code (NEC).
  - 3. All user serviceable wiring shall be type MTW or THW, 600 volts, and shall be color-coded as follows:
    - a. Line and load circuits, AC or DC power Black
    - b. AC control circuit less than line voltage Red
    - c. DC control circuitBlue
    - d. Interlock control circuit, from external source Yellow
    - e. Equipment grounding conductor
    - f. Current carrying ground White
    - g. Hot with circuit breaker open Orange
- B. Wire Identification and Sizing:
  - 1. Control circuit wiring inside the panel, with the exception of internal wiring of individual components, shall be 16-gauge minimum, type MTW or THW, 600 volts. Motor branch wiring shall be 10-gauge minimum.

Green

2. Motor branch conductors and other power conductors shall not be loaded above 60-degree C temperature rating, on circuits of 100 amperes or less, nor above 75-degree C on circuits over 100 amperes. Wires shall be clearly numbered at each end in conformance with applicable standards. All wire connectors in the control panel shall be of the ring tongue type with nylon insulated shanks. All wires on the sub-plate shall be bundled and tied or installed in duct. All wires extending from components mounted on door shall be

terminated on a terminal block mounted on the back panel. All wiring outside the panel shall be installed in conduit.

- C. Wire Bundles:
  - 1. Control conductors connecting components mounted on the enclosure door shall be bundled and tied in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall be allowed so that the door can swing to its full open position without undue mechanical stress or abrasion on the conductors or insulation. Bundles shall be clamped and held in place with mechanical fastening devices on each side of the hinge.
- D. Conduit:
  - 1. All conduit and fittings shall be UL listed.
  - 2. Liquid tight flexible metal conduit shall be constructed of a smooth, flexible, galvanized steel core with a smooth abrasion resistant, liquid tight, polyvinyl chloride cover.
  - 3. Conduit shall be supported in accordance with Articles 346, 347, and 350 of the National Electric Code.
  - 4. Conduit shall be sized according to the National Electric Code.
- E. Grounding:
  - 1. The pump control manufacturer shall ground all electrical equipment to the enclosure back panel. The mounting surface of all ground connections shall have any paint removed before making final connections.
  - 2. The contractor shall provide an earth driven ground connection to the control panel at the main ground lug in accordance with the National Electric Code (NEC).

### 2.9 LEVEL CONTROL SYSTEM

- A. Liquid Level Control:
  - 1. The level control system shall be a Gorman-Rupp Integrinex Standard Electronic Pressure Switch controller.
  - 2. The manufacturer of the liquid level control system must be ISO 9001:2000 revision certified, with scope of registration including design control and service after sales activities.
  - 3. The level control system shall start and stop the pump motors in response to changes in wet well level, as set forth herein.
  - 4. The level control system shall be furnished as an air bubbler type level control system; however, it must be capable of being operated as a submersible transducer type system or ultrasonic transmitter type system.
  - 5. The level control system shall incorporate automatic alternation to select first one pump, then the second pump to run as lead pump for a pumping cycle. Alternation shall occur at the end of a pumping cycle, or in the event of excessive run time.
  - 6. The level control system shall utilize an electronic pressure switch, which shall continuously monitor the wet well level, permitting the operator to read wet well level at any time. Upon operator selection of automatic operation, the electronic pressure switch shall start the motor for one pump when the liquid level in the wet well rises to the "lead pump start level". When the liquid is lowered to the "lead pump stop level", the electronic pressure switch shall stop this pump. These actions shall constitute one pumping cycle. Should the wet well level continue to rise, the electronic pressure switch shall start the second pump when the liquid reaches the "lag pump start level. These levels shall be adjustable as described below.
    - a. The electronic pressure switch shall include integral components to perform all pressure sensing, signal conditioning, EMI and RFI suppression, DC power supply

and 120 volt outputs. Comparators shall be solid state, and shall be integrated with other components to perform as described below.

- b. The electronic pressure switch shall be capable of operating on a supply voltage of 12-24VDC in an ambient temperature range of -10 degrees C (14 degrees F) through 55 degrees C (131 degrees F). Ingress Protection of IP56 for indoor use with closed cell neoprene blend gasket material. Evaluated by Underwriters Laboratories for Pollution Degree 2 device for U.L. and cU.L. Control range shall be 0 to 33.3 feet of water with an overall repeat accuracy of (plus/minus) 0.1 feet of water. Memory shall be retained using a non-volatile lithium battery back-up.
- c. Eleven optically isolated, user defined digital inpurs for pump and alarm status. Rated at 10mA at 24VDC. Eight digital output relays (mechanical contacts), configurable for pump start/stop or alarms. Three relays rated at 12A at 28VDC and 120 VAC, five relays rated at 3A at 30VDC and 120VAC. The electronic pressure switch shall consist of the following integral components: pressure sensor, display, electronic comparators, digital inputs and digital output relays.
  - 1) The internal pressure sensor shall be a strain gauge transducer and shall receive an input pressure from the air bubbler system. The transducer shall convert the input to a proportional electrical signal for distribution to the display and electronic comparators. The transducer output shall be filtered to prevent control response to level pulsations or surges. The transducer range shall be 0-14.5 PSI, temperature compensated from -40 degrees C (-40 degrees F) through 85 degrees C (185 degrees F), with a repeat accuracy of (plus/minus) 0.25% full scale about a fixed temperature. Transducer overpressure rating shall be 3 times full scale.
  - 2) The electronic pressure switch shall incorporate a digital back lighted LCD panel display which, upon operator selection, shall indicate liquid level in the wet well, and pump status indication for up to 3 pumps. The display shall include a 128 x 64 bit resolution LCD to read out directly in feet of water, accurate to within one-tenth foot (0.1 foot), with a full-scale indication of not less than 12 feet. The display shall be easily convertible to indicate English or metric units.
  - 3) Level adjustments shall be electronic comparator set points to control the levels at which the lead, lag, and standby pumps start and stop. Each of the level settings shall be easily adjustable with the use of membrane type switches, and accessible to the operator without opening any cover panel on the electronic pressure switch. Controls shall be provided to permit the operator to read the selected levels on the display. Such adjustments shall not require hard wiring, the use of electronic test equipment, artificial level simulation or introduction of pressure to the electronic pressure switch.
  - 4) Each digital input can be programmed as pump run, pump HOA, pump high temp, pump moisture/thermal, starter failure (FVNR, RVSS, VFD), and phase failure. Inputs are used for status and alarm indication.
  - 5) Each output relay in the electronic pressure switch shall be hard contact mechanical style. Each relay input shall be optically isolated from its output and shall incorporate zero crossover switching to provide high immunity to electrical noise. Each output relay shall have an inductive load rating equivalent to one NEMA size 3 contactor. A pilot relay shall be incorporated for loads greater than a size 3 contactor

- d. The electronic pressure switch shall be equipped with alarm banners with time and date history for displaying alarm input notification. Alarm history will retain 16 of the most recent alarm events.
- e. The electronic pressure switch shall be capable of jumping to next available pump if current pump is out of service due to pump failure or manual selection. Circuit design in which application of power to the lag pump motor starter is contingent upon completion of the lead pump circuit shall not be acceptable.
- f. The electronic pressure switch shall be equipped with a simulator system capable of performing system cycle testing functions.
- g. The electronic pressure switch shall be capable of controlling liquid levels in either a pump up or pump down application.
- h. The electronic pressure switch shall be equipped with pump start/stop and alarm input delay(s) that have an adjustable delay set points.
- i. The electronic pressure switch shall be capable of calculating and displaying pump elapsed run time. The elapsed run time is resettable and adjustable.
- j. An Antiseptic function with a built in timer shall be incorporated in the electronic pressure switch to prevent the well from becoming septic.
- k. The electronic pressure switch shall have internal capability of providing automatic simplex, duplex, and triplex automation, manual selection of pump sequence operation, and alternation in the event of 1-24 hours of excessive run time.
- 1. The electronic pressure switch shall be equipped with a security access code to prevent accidental set-up changes and provide liquid level set-point lock-out. The supervisor access code is adjustable.
- m. The electronic pressure switch shall be equipped with one (1) 0-33 ft. W.C. input, one (1) scalable analog input of either 0-5VDC or 4-20mA, and one (1) scalable analog output of either 0-5VDC, 0-10VDC, or 4-20mA. Output is powered by 10-24VDC supply. Load resistance for 4-20mA output shall be 100-1000 ohms.
- n. The electronic pressure switch shall include a DC power supply to convert 120 VAC control power to 12 or 24VDC power. The power supply shall be 500-mA (6W) minimum and be UL listed Class II power limited power supply.
- o. The electronic pressure switch shall be equipped with an electronic comparator and mechanical output relay to alert maintenance personnel to a high liquid level in the wet well. An alarm banner, visible on the front of the controller, shall indicate that a high wet well level exists. The alarm signal shall be maintained until the wet well level has been lowered and the circuit has been manually reset. High water alarm shall be furnished with a dry contact wired to terminal blocks.
- 7. An alarm silence pushbutton and relay shall be provided to permit maintenance personnel to de-energize the audible alarm device while corrective actions are under way. After silencing the alarm device, manual reset of the alarm condition shall clear the alarm silence relay automatically. The pushbutton shall be a membrane style button integral to the Integrinex Standard level controller.
- B. Air Bubbler System:
  - 1. The level control system shall be the air bubbler type, containing air bubbler piping, which extends into the wet well. A pressure sensor contained within the electronic pressure switch shall sense the air pressure in this piping to provide wet well level signals for the remainder of the level control system.
  - 2. Two vibrating reeds, industrial rated, air pumps shall be furnished to deliver free air at a rate of approximately 5 cubic feet per hour and a pressure not to exceed 7 psi. Liquid level control systems utilizing air compressors delivering greater quantities of air at higher pressures, requiring pressure-reducing valves, air storage reservoirs, and other

maintenance nuisance items will not be acceptable. A selector switch shall be furnished to provide manual alternation of the air pumps. The switch shall be connected in such a manner that either pump may be selected to operate continuously. The selector switch shall be oil-tight design with contacts rated NEMA A300 minimum.

- 3. An air bell constructed of PVC 3 inches in diameter shall be provided for installation at the outlet of the air bubbler line in the wet well. The air bell shall have a 3/8" NPT tapped fitting for connection to the bubbler line.
- 4. An air flow indicator gauge shall be provided and connected to the air bubbler piping to provide a visual indication of rate of flow in standard cubic feet per hour.

# 2.10 TELEPHONE DIALER - CELLULAR

- A. Specifications:
  - 1. Furnish and install a Cellular Telephone Alarm Dialer ("Dialer"). Dialer shall be completely factory assembled and tested before shipment. The telephone dialer shall be Model XR50 as manufactured by OmniSite, Greenwood, IN, and as supplied by Envirep, Inc., Camp Hill, PA (717-761-7884).
  - 2. Enclosure shall be NEMA 4X, 12-inches high, 10-inches wide, 4-inches deep with hinged clear cover suitable for indoor mounting.
  - 3. Dialer shall monitor three (3) pump run universal inputs that accept dry contact closures or voltage signals from +/-12VDC/VAC to +/-120 VDC/VAC. These inputs shall monitor pump run time, count pump run cycles and calculate total station flow and pumping rates. The pump run universal inputs shall be connected to motor starter auxiliary run contacts as follows:
    - a. Pump #1 run contact
    - b. Pump #2 run contact
    - c. Pump #3 run contact
  - 4. Dialer shall monitor seven (7) universal inputs (in addition to the three (3) pump run inputs) that accept dry contact closures or voltage signals from +/-12VDC/VAC to +/-120 VDC/VAC. Input #5 shall also be configurable as a rain gauge input. Inputs #6 and #7 shall also be configurable as counter inputs and shall be capable of accepting pulse inputs from flow meters to report totalized daily flow.
  - 5. The seven (7) universal inputs shall be configured for alarm conditions as follows:
    - a. High water alarm
    - b. Phase failure
    - c. Pump fault, common
    - d. Station low temperature
    - e. High water (float)
    - f. Spare
    - g. Spare
  - 6. The device shall include the following items:
    - a. LCD display, 2 line, 16 character
    - b. Modbus RS232 port
    - c. SD memory card slot
    - d. Intelligent key for disabling dialer
    - e. Battery charging power supply
    - f. Battery backup
    - g. Lightning arrestor solid state
    - h. Removable terminal blocks
    - i. UL 508 certification
    - j. Antenna

- B. Functionality and Capabilities:
  - 1. System shall be capable of the following functions (reported daily):
    - a. Number of pump on/off cycles per day
    - b. Pump run times
    - c. Average drawdown time
    - d. Average GPM for each pump (Volumetric)
    - e. Total flow, gallons
    - f. Average daily flow, gallons
    - g. Average daily influent flow, GPM
  - 2. All alarm functions shall be processed immediately.
  - 3. All non-alarm functions shall be reported on a daily basis and shall be accessible and displayed over the Internet.
  - 4. Upon alarm condition, the dialer shall make telephone calls, send messages to pagers, and/or send emails to a user programmable contact list.
  - 5. The dialer shall have the ability to be programmed, setup and monitored over the Internet. Password protected web pages shall provide multiple levels of secure access. Web pages shall be used to view current status of alarms, view alarm history, view pump run times and set up the dialer. Local unit setup shall be performed with a keypad and menu system. Units requiring a separate computer for local programming shall not be acceptable.
  - 6. Dialers that require proprietary programming software are not acceptable.
  - 7. Historical data shall be exportable to Microsoft Excel or Word.
  - 8. Monthly fee shall be independent of the number of alarm conditions, phone calls, or information exchange transactions.
  - 9. A toll free phone number shall be provided to receive a current alarm status report and to acknowledge alarms.
- C. Installation:
  - 1. The contractor shall install the dialer and provide the following:
    - a. 115 VAC, 60 Hz, 15 amp, single-phase power wiring with circuit breaker protection
    - b. Good electrical ground connection
    - c. Interconnecting alarm and input wiring from monitored equipment and devices to dialer.
    - d. Mount dialer in accordance with manufacturer's recommendations.
    - e. Mount and wire antenna
- D. Startup Service:
  - 1. Manufacturer's service technician shall provide startup and operator training. Start up service shall include complete testing of each individual alarm input. Testing shall include documented verification that all alarms properly trigger the final notification device (cell phone, pager, email, etc).
- E. Warranty:
  - 1. The dialer shall be supplied by the pump station supplier and shall carry a one (1) year factory warranty. The factory warranty shall cover the cost of all parts and labor for equipment repairs performed at the factory. Warranty shall commence upon startup or 3 months after shipment, whichever occurs first.
- F. Cellular Service:
  - 1. Equipment purchase price includes 3 years of cellular service fees commencing at the activation date of the unit. Afterward, cellular service fees shall be billed annually directly to the municipality.

## 2.11 INDEPENDENT HIGH WATER ALARM FLOAT

A. A float switch shall be mounted in the wet well and wired to the telephone dialer to serve as an independent high water alarm. Float switch shall be non-intrinsically safe.

### 2.12 REDUNDANT HIGH WATER ALARM FLOAT

- A. A float switch shall be mounted in the wet well and wired in parallel to the standard high water alarm relay to serve as a redundant high water alarm.
  - 1. Float switch shall be mercury free
  - 2. NEMA 4X stainless steel wet well junction box
  - 3. Float switch shall include an anchor and stainless steel chain
  - 4. Intrinsically safe barrier

### PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Pumping equipment manufacturer shall provide written instructions for proper handling. Immediately after off-loading, contractor shall inspect pumping equipment and appurtenances for shipping damage or missing parts.
- B. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all serial numbers and parts lists with shipping documentation. Notify manufacturer's representative of any unacceptable conditions noted with shipper.

## 3.2 INSTALLATION

- A. Install, level, and align pump station as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacturer at time of delivery.
- B. Suction pipe connections must be vacuum tight. Fasteners at all pipe connections must be tight. Install pipe with supports and thrust blocks to prevent strain and vibration on pump system piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required in wet well.
- C. Provide adequate clearance for removal of pump rotating assembly and cover plate.
- D. Each air release valve shall have a separate air release discharge pipe back to the wet well for each air release valve. Discharge pipe shall be minimum 1-1/2-inch diameter, and constantly downward slope towards the wet well.
- E. Check motor and control data plates for compatibility to site voltage. Install and test the electrical ground prior to connecting line voltage to pump control panel.
- F. Prior to applying electrical power to motors or control equipment, check all wiring for tight connection. Verify that fuses and circuit breakers conform to project design documents. Manually operate circuit breakers and switches to ensure operation without binding. Open all circuit breakers and disconnects before connecting utility power. Verify line voltage, phase sequence and ground before actual start-up.
- G. After all anchor bolts, piping connections are installed, seal all openings between wet well and pump enclosure.
- H. If determined by the engineer and/or manufacturer at startup, that grouting the pump/motor base is needed, the contractor shall be responsible to install grout to the pump/motor base. If grout is installed, the contractor shall ensure that the grout does not interfere with the pump/motor/belt guard adjustment or mounting hardware.

### 3.3 **PROTECTION**

- A. The pumping equipment should be placed into service soon after delivery of the equipment. If installation is delayed, the pumping equipment and control panel shall be stored indoors, free of excessive dust, in a low humidity, heated environment.
- B. During installation and after the pumping equipment is placed into operation the control panel shall operate in an environment free of excessive dust, in a low humidity, heated environment.

## 3.4 FIELD QUALITY CONTROL

- A. Prior to acceptance by the owner, an operational test of all pumps drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.
- B. Prior to start-up, clean wet well by removing construction debris and foreign material.

## 3.5 MANUFACTURER'S PRE-STARTUP INSPECTION

- A. Coordinate system pre-startup with manufacturer's factory-trained service technician. The factory-trained service technician will inspect the installation and answer any installation questions by the Contractor, Engineer, or Owner.
- B. Manufacturer's representative shall provide pre-startup checklist to be completed by the contractor prior to pre-startup inspection.
- C. Verify that operations and maintenance manual is on site and installation instructions contained in the manual have been followed.
- D. Verify that all pumping equipment, piping, level control system, alarms and ancillary equipment has been properly installed and all wiring is complete.
- E. Verify that all spare parts for the pumping equipment are on site.
- F. Pre-startup inspection shall be a separate trip and shall not be less than two weeks prior to the startup of the equipment.

# 3.6 MANUFACTURER'S STARTUP AND FIELD PERFORMANCE TESTING

- A. Coordinate system start-up with manufacturer's factory-trained service technician. The factory-trained service technician will inspect the completed installation, calibrate and adjust instrumentation, and correct or supervise correction of defects or malfunctions. Startup shall be performed in the presence of the Engineer and Owner.
- B. Equipment startup shall be tested under both utility power and emergency power.
- C. Contractor shall supply clear water of adequate volume to operate the system including the force main through several pumping cycles.
- D. Contractor shall have an electrician present at startup to resolve any wiring issues.
- E. Observe and record operation of pumps, suction and discharge gage readings, voltage readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment. Test manual and automatic control systems. Test all alarms. Report any undue noise, vibration or other operational problems.
- F. Startup shall be a separate trip.

## 3.7 MANUFACTURER'S OPERATION AND MAINTENANCE TRAINING

A. The manufacturer shall furnish the services of a qualified, factory-trained operations and maintenance serviceman to instruct and train Owner's personnel in the proper care, operation

and maintenance of the equipment. The training shall include, but not be limited to, the following:

- 1. Theory of operation
- 2. Actual operation
- 3. Mechanical maintenance
- 4. Hydraulic troubleshooting
- 5. Electrical maintenance
- 6. Instrumentation and level controls
- 7. Optimization of the system
- 8. Alarm circuits
- 9. Safe operating and working practices and operation of safety devices.
- B. One (1) training session is required. Training shall be completed after startup services have been performed. Training shall be a separate trip and shall not be less than two weeks after the startup of the equipment. Time, location, and duration of all training sessions shall be coordinated with Owner's personnel.
- C. Hands-on training and demonstrations shall use the installed equipment.
- D. Supplier shall provide all materials for training and shall provide training manuals to all personnel being trained.

### 3.8 MANUFACTURER'S EQUIPMENT RE-CERTIFICATION

- A. The Contractor shall require, and cover the cost in his bid, for the manufacturer's factorytrained service technician to return to the site six (6) month's after initial startup of the equipment to perform a final re-certification of the equipment.
- B. The re-certification shall consist of demonstrating and certifying that the equipment is meeting the performance requirements of the specifications. Equipment service technician shall perform field-testing of the equipment in the presence of the Owner. Results of all field-testing shall be submitted to the Engineer and the Owner.

### 3.9 CLEANING AND HOUSEKEEPING

A. Prior to acceptance, inspect interior and exterior of pump station for dirt, splashed material or damaged paint. Clean or repair accordingly. Use touch-up paint provided under spare parts to repair any painted surfaces damaged during installation or startup. Remove from the job site all tools, surplus materials, scrap and debris.

# END OF SECTION

#### SECTION 33 41 00 - STORM DRAINAGE

#### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1, Specifications Section, apply to work in this section.

#### 1.2 DESCRIPTION OF WORK

A. This section specifies materials and work required to construct storm drainage system.

#### 1.3 RELATED WORK

A. Refer to Section 31 10 00 "Clearing", Section 31 20 00 "Earthmoving", Section 33 10 00 "Utility Standards"; Section 32 13 13 "Concrete Paving" and Division 22 "Plumbing".

#### 1.4 STANDARDS

- A. Frederick County Department of Transportation current "Design Standards".
- B. Maryland Department of Transportation State Highway Administration current "Standard Specifications for Construction and Materials".
- C. Maryland Standards and Specifications for Soil Erosion and Sediment Control, current edition.
- D. American Concrete Pipe Association (ACPA).
- E. Cast Iron Soil Pipe Institute (CISPI).

#### 1.5 SUBMITTALS

- A. Products:
  - 1. Submit certificate signed by manufacturer and contractor stating that pipe and pipe joint materials comply with this specification.
  - 2. Submit shop drawings of pre-cast reinforced structures and cast in place reinforced concrete structures indicating location, size and placement of concrete reinforcement.
  - 3. Submit manufacturer's descriptive literature of cleanouts.
  - 4. Submit location of product manufacture.
  - 5. Special shop drawing and submittal reviews are those requiring third-party (governing agency) review and approval in addition to normal reviews by the Owner, the Architect and/or the Engineer of Record. In instances where shop drawings and contractors submittals must also be reviewed and approved by municipal agencies or other entities, the normal review turnaround time shall be extended by the Contractor as required to accommodate these reviews and approvals at no additional cost or delay to the Owner, the Architect and/or the Engineer of Record. The contractor shall schedule and/or adjust work schedules accordingly.

6. The contractor shall bear all surveying, engineering and permitting costs for re-design and/or re-engineering required for substitutions and/or to expedite construction and/or accommodate changes in the contractor's construction methods and means.

### 1.6 PROJECT CONDITIONS

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Existing Storm Drainage System: Provide, install, operate and maintain pumps and related equipment required to divert storm water during system construction.
- C. Traffic: Maintain pedestrian and vehicular traffic during system construction.
- D. As-Built Documents:
  - 1. Refer to Section 33 10 00 "Utility Standards

### 1.7 CONSTRUCTION SURVEYS:

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 25 feet maximum and at all structures. Provide construction cut sheet preparation as required.

#### PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Provide products manufactured within a 500-mile radius of the Project Site
- B. Polyvinyl Chloride (PVC) Pipe: ASTM D 3034, SDR 35 PVC gravity sewer pipe, size as indicated, standard manufacture laying length.
  - 1. Pipe Joints: ASTM D 3212, bell and spigot type, with flexible elastomeric gasket seals. Gaskets shall meet the requirements of ASTM F 477.
  - 2. Fittings shall be as indicated and required.
- C. Cast Iron Soil Pipe: ASTM A 74, extra heavy, coal tar coating, size as indicated, standard manufacture laying length.
  - 1. Pipe Joints and Fittings: ASTM A 74, hub and spigot joint type manufactured for rubber gaskets. Rubber gaskets per ASTM C 564. Joint lubricant of vegetable oil soap. Fitting types as indicated or required.
- D. Concrete Pipe: ASTM C 76, Class IV, standard manufacture laying length.
  - 1. Pipe Joints: Rubber gaskets, ASTM C 443 with vegetable oil soap joint lubricant.
  - 2. Mortar Joints: Modified tongue and groove pipe with cement mortar.
- E. Corrugated Steel Pipe: ASTM A 819 and AASHTO M 274 Aluminized Steel Type 2 pipe, corrugations and thickness as specified on plans.
  - 1. Pipe Joints: Shall be watertight joints, made with bands gaskets as specified on plans.

- F. High Density Polyethylene Pipe: ADS Type N-12.
  - 1. Pipe Joints: All joints must meet a modified ASTM 3212 at 3.5-psi held for 10 minutes as certified by an independent testing laboratory.
- G. Structures: Standards specified and as indicated.
- H. Structure Castings: MDOT-SHA or Frederick County Standards.
  - 1. Grates for storm drain inlets with grate tops shall be waffle shaped for wheel chair and bicycle safety. Slots shall not exceed 4" by 1 1/2".
- I. PVC Pipe for Infiltration Drywell: Schedule 40 Polyvinyl Chloride (PVC) sewer pipe as indicated and required by Frederick County.
  - 1. Size: As indicated.
  - 2. Perforations: Drill 1/4-inch perforations all around for entire length as indicated.
  - 3. Fittings: As indicated and required.
- J. Cleanouts:
  - 1. Cleanout Ferrules and Plugs: Josam Series No. 58490 with cast iron body and bronze countersunk flanged plug. Size matching pipe size indicated. Contractor shall provide Owner with two "T" handles for recessed plugs.
  - 2. Cleanouts For Use in Paved Walk Areas: Josam Series No. 58360 adjustable floor cleanout with cast iron body and bronze plug and top. Size matching pipe size indicated. Contractor shall provide Owner with one cleanout wrench.
    - a. Expansion Joint: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.
  - 3. Fittings: Shall be as specified for PVC pipe (for pipe materials indicated).
- K. Filter Fabric: "Mirafi 140N" manufactured by Mirafi Incorporated, Charlotte, North Carolina. Contractor's Option: "Typar", type 3341 manufactured by Remay Incorporated, Nashville, Tennessee.
  - 1. Quality: Free of defects of flaws, which affect strength or filtering properties.
- L. Sand: ASTM C33 Fine Aggregate.
- M. Concrete: Refer to Section 33 10 00 "Utility Standards".
- N. Reinforcing Steel and Hardware: Refer to Section 33 10 00 "Utility Standards", and as noted:
  - 1. Size and type of steel and hardware shall be as indicated.
  - 2. Exposed reinforcing steel shall be hot dip galvanized, ASTM A 767, Coating Class I.
  - 3. Hardware shall be hot dip galvanized, ASTM A 153.
- O. Miscellaneous Products:
  - 1. Underground identification tape manufactured by Allen Systems, Houston, Texas. Tape shall be three inches wide, "Detectatape" type, "Safety Green" color, and marked "Caution Sewer Line Buried Below".

PART 3 - EXECUTION

#### 3.1 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH:

A. Refer to Section 33 10 00 "Utility Standards".

### 3.2 CONNECTIONS TO EXISTING SYSTEM

- A. For structure construction over existing pipe, excavate and expose existing pipe at structure location indicated. Adjust structure location as directed by the Owner's Representative in the event existing pipe joint interferes with structure walls, at no increase to Contract Sum. Manually excavate below existing pipe prior to structure base placement. Place concrete base and construct structure as specified. Neatly cut and remove upper half of existing pipe and construct invert flow channel.
- B. For pipe connections to existing structures, excavate and expose existing structure. Cut and remove portion of existing structure wall required for pipe connection. Install pipe, through existing structure wall, flush with interior wall surface. Remove portion of existing invert flow channel required for connection and reconstruct as specified. Fill joint between pipe and existing structure wall with cement mortar.
- 3.3 PIPE:
  - A. General: Install in accordance with manufacturer's installation instructions and as noted. Inspect each pipe laying length and pipe joint materials for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Begin installation at lowest system elevation and proceed up-grade. Field cut pipe only where required to complete structure-to-structure closures, install fittings or as specified. Cut pipe to smooth square end.
  - B. Cast Iron Pipe: Install with spigot end of pipe pointing in direction of flow. Install fittings where indicated or required. Clean and lubricate joints, immediately prior to joining pipe, in accordance with manufacturer's recommendation. Position each laying length in previously installed pipe and push joint tightly together.
  - C. Concrete Pipe: Install with tongue end of pipe pointing in direction of flow. Clean and thoroughly wet joints immediately prior to joining pipe. Apply thick liberal coat of mastic to groove and tongue. Position each laying length in previously installed pipe and pull joint tightly together with mechanical device designed for pipe jointing.
    - 1. Clean interior of each joint removing excess cement mortar and finish flush with surface. Fill exterior upper half of pipe joint with cement mortar.
  - D. Polyvinyl Chloride (PVC) Pipe: Install pipe in accordance with ASTM D 2321, manufacturer's installation instructions, and as noted.
    - 1. Install with pipe spigot end pointing in flow direction. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed up-grade. Clean bell and spigot interior and exterior surfaces, removing oil, grit and foreign matter. Lubricate pipe ends and gasket in accordance with manufacturer's instructions. Position each laying length of previously installed pipe and manually push joint tightly together.
    - 2. Field Pipe Cutting: Shape spigot end of cut pipe to resemble manufactured spigot end, with a pipe-beveling tool designed for PVC pipe. Copy the full insertion mark provided on the manufactured spigot end onto the prepared field cut end.
- E. Corrugated Steel Pipe: Install in accordance with manufacturer's recommendations and instructions, and ASTM A 798.
- F. High Density Polyethylene Pipe: Install in accordance with manufacturer's recommendations.

# 3.4 CLEANOUTS

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. Install cleanouts and construct concrete pads of Class "A" concrete as indicated.
- C. Cleanout in paved walk area shall be installed without a concrete pad. Top shall be cast into and set flush with finished walk surface.

### 3.5 STRUCTURES

A. Refer to Section 33 10 00 "Utility Standards" and as noted. Neatly cut pipes flush with interior structure walls. Construct invert flow channels smooth and semicircular in shape. Shape channels with horizontal circular curves, with radii as large as structure will permit or as indicated. Neatly form channels in structure base with bricks and cement mortar. Provide steps in structures exceeding 3.0 feet in depth. Steps shall be per Frederick County Standards. Vertical step spacing per standards specified.

### 3.6 BACKFILL

- A. Refer to Section 33 10 00 "Utility Standards", and as noted.
- B. Polyvinyl Chloride (PVC) Pipe: Conduct backfill operations when pipe temperature is below 60 degrees Fahrenheit or during early morning hours to prevent excessive contraction.
- C. Underground Identification Tape: Install during backfill operations. Center tape horizontally over pipe, 12 inches above top of pipe.

### 3.7 STORMWATER MANAGEMENT

- A. The Contractor shall be responsible for all efforts necessary to deliver a County approved stormwater management system within 60 days of final site stabilization.
- B. The Contractor shall keep all as-built information current on a record set of drawings as the stormwater management system is being constructed.
- C. The Contractor shall be responsible for pumping down and cleaning of the system as required for final inspection and acceptance by Frederick County.
- D. Final County approval and close out of the stormwater management and sediment control permits are required before contract completion is achieved for stormwater management work.

- E. Collect and provide any and all supporting certifications required to satisfy all as-built requirements. Provide certifications from suppliers (including delivery tickets) for materials used in the construction of the facilities (principal spillway, control structure, pvc pipe, aggregate, wetland plantings, granite blocks, rip-rap, geotextile fabric, etc.).
- F. Provide the following to the design engineer to support the stormwater as-builts:
  - 1. Topographic survey of the stormwater management and storm drainage systems in AutoCAD format (.dwg)
  - 2. Topographic survey of the stormwater management and storm drainage systems plotted in red on mylar. The plot should be on the approved stormwater management plans and profiles. The survey shall include as-built contours, core trench elevations, elevations, dimension, depth of rip-rap, etc. Any deviations from the approved plans shall be shown with a box around the elevation or dimension.
  - 3. The plan shall be signed and sealed by the contractor's surveyor with the following certification: "I hereby certify to the best of my knowledge and belief that this as-built truly represents existing field conditions including but not limited to sizes, diameters, line and grade, and elevations."
  - 4. Provide three ties to locate all structures horizontally on the plans.
- G. Provide the date/time-stamped digital (.jpg) photographs documenting the chronology of the construction of all stormwater management facilities from beginning to end to the owner in hard copy and electronic format.

# **END OF SECTION**