

STATE OF DELAWARE
CAESAR RODNEY SCHOOL DISTRICT
CONTRACT # SRS-18-012-NEWLEM

SPECIFICATIONS
VOLUME 4

FOR

NEW CAESAR RODNEY ELEMENTARY SCHOOL

IN

Magnolia, Delaware

PREPARED
BY



ARCHITECTURE
ENGINEERING

Becker Morgan Group, Inc.

BIDDING DOCUMENTS
May 14, 2018

DOCUMENT 000101 - PROJECT TITLE PAGE**1.1 PROJECT MANUAL VOLUME 4**

- A. New Caesar Rodney Elementary School.
- B. Magnolia, Delaware.
- C. Owner Project No. SRS-18-012-NEWELM.
- D. Architect Project No. 2017073.00.
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LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Single conductor building wire.
- B. Underground feeder and branch-circuit cable.
- C. Armored cable.
- D. Metal-clad cable.
- E. Wiring connectors.
- F. Electrical tape.
- G. Heat shrink tubing.
- H. Oxide inhibiting compound.
- I. Wire pulling lubricant.
- J. Cable ties.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 05 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 28 31 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.
- F. Section 31 23 16 - Excavation.
- G. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
- H. Section 31 23 23 - Fill: Bedding and backfilling.

1.03 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation.
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
- F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- H. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC).
- I. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.

- J. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- K. NFPA 70 - National Electrical Code.
- L. UL 4 - Armored Cable.
- M. UL 44 - Thermoset-Insulated Wires and Cables.
- N. UL 83 - Thermoplastic-Insulated Wires and Cables.
- O. UL 486A-486B - Wire Connectors.
- P. UL 486C - Splicing Wire Connectors.
- Q. UL 486D - Sealed Wire Connector Systems.
- R. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
- S. UL 1569 - Metal-Clad Cables.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.
- D. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS**2.01 CONDUCTOR AND CABLE APPLICATIONS**

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- H. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- I. Conductor Material:
 - 1. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
 - 2. Tinned Copper Conductors: Comply with ASTM B33.
- J. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
 - 2. Control Circuits: 14 AWG.
- K. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 - 3. Color Code:

- a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
- b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
- c. Equipment Ground, All Systems: Green.
- d. Isolated Ground, All Systems: Green with yellow stripe.
- e. Travelers for 3-Way and 4-Way Switching: Pink.
- f. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - 1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com.
 - b. Southwire Company: www.southwire.com.
 - c. Houston Wire & Cable co.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
 - 2. Control Circuits: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2.
 - b. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.04 ARMORED CABLE

- A. Manufacturers:
 - 1. AFC Cable Systems Inc: www.afcweb.com.
 - 2. Encore Wire Corporation: www.encorewire.com.
 - 3. Southwire Company: www.southwire.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type AC cable listed and labeled as complying with UL 4, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN.

- F. Grounding: Combination of interlocking armor and integral bonding wire.
 - 1. Provide additional full-size integral insulated equipment grounding conductor for redundant grounding, suitable for general purpose, non-essential electrical systems in non-hazardous patient care areas of health care facilities.
- G. Armor: Steel, interlocked tape.

2.05 METAL-CLAD CABLE

- A. Manufacturers:
 - 1. AFC Cable Systems Inc: www.afcweb.com.
 - 2. Encore Wire Corporation: www.encorewire.com.
 - 3. Southwire Company: www.southwire.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
- F. Provide dedicated neutral conductor for each phase conductor where indicated or required.
- G. Grounding: Full-size integral equipment grounding conductor.
 - 1. Provide additional isolated/insulated grounding conductor where indicated or required.
- H. Armor: Steel, interlocked tape.
- I. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.06 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Sizes 10 and under: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Sizes 8 and larger: Use mechanical connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 - 4. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

1. Manufacturers:

- a. 3M: www.3m.com.
- b. Ideal Industries, Inc: www.idealindustries.com.
- c. NSI Industries LLC: www.nsiindustries.com.
- d. Substitutions: See Section 01 60 00 - Product Requirements.

H. Mechanical Connectors: Provide bolted type or set-screw type.

1. Manufacturers:

- a. Burndy: www.burndy.com.
- b. IlSCO: www.ilSCO.com.
- c. Thomas & Betts Corporation: www.tnb.com.
- d. Substitutions: See Section 01 60 00 - Product Requirements.

I. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

1. Manufacturers:

- a. Burndy: www.burndy.com.
- b. IlSCO: www.ilSCO.com.
- c. Thomas & Betts Corporation: www.tnb.com.
- d. Substitutions: See Section 01 60 00 - Product Requirements.

2.07 WIRING ACCESSORIES

A. Electrical Tape:

1. Manufacturers:

- a. 3M: www.3m.com.
- b. Plymouth Rubber Europa: www.plymouthrubber.com.
- c. Substitutions: See Section 01 60 00 - Product Requirements.

2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.

- a. Product: 3 M.
- b. Substitutions: See Section 01 60 00 - Product Requirements.

3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.

- a. Product: 3 M.
- b. Substitutions: See Section 01 60 00 - Product Requirements.

4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.

5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.

6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.

7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Burndy: www.burndy.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
 1. Manufacturers:
 - a. Burndy: www.burndy.com.
 - b. Ideal Industries, Inc: www.idealindustries.com.
 - c. Ilasco: www.ilasco.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
 1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. American Polywater Corporation: www.polywater.com.
 - c. Ideal Industries, Inc: www.idealindustries.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as shown on the drawings.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:
 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 2. When circuit destination is indicated and routing is not shown, determine exact routing required.
 3. Arrange circuiting to minimize splices.
 4. Include circuit lengths required to install connected devices within 10 ft of location shown.
 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is not permitted.
- B. Install products in accordance with manufacturer's instructions.
- C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
- D. Install armored cable (Type AC) in accordance with NECA 120.
- E. Install metal-clad cable (Type MC) in accordance with NECA 120.

- F. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- I. Terminate cables using suitable fittings.
 - 1. Armored Cable (Type AC):
 - a. Use listed fittings and anti-short, insulating bushings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
 - 2. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- J. Install conductors with a minimum of 12 inches of slack at each outlet.
- K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
- L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- N. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- O. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.

- b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
- 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
- 3. Wet Locations: Use heat shrink tubing.
- P. Insulate ends of spare conductors using vinyl insulating electrical tape.
- Q. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- R. Identify conductors and cables in accordance with Section 26 05 53.
- S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- T. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground enhancement material.
- G. Ground access wells.
- H. Grounding and bonding components.
- I. Provide all components necessary to complete the grounding system(s) consisting of:
 - 1. Existing metal underground water pipe.
 - 2. Metal frame of the building.
 - 3. Existing metal underground gas piping system.
 - 4. Metal underground gas piping system.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 56 00 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.03 REFERENCE STANDARDS

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- E. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.
- F. NFPA 70 - National Electrical Code.
- G. UL 467 - Grounding and Bonding Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 25 ohms.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Shop Drawings:
- D. Product Data: Provide for grounding electrodes and connections.
- E. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Project Record Documents: Record actual locations of grounding electrode system components and connections.
- H. Project Record Documents: Record actual locations of components and grounding electrodes.

1.07 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS**2.01 GROUNDING AND BONDING REQUIREMENTS**

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. Grounding System Resistance:
 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
- E. Grounding Electrode System:
 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 3. Metal Building or Structure Frame:
 - a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
 4. Ground Ring:
 - a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
 - b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
 - c. Provide ground enhancement material around conductor where indicated.
 - d. Provide connection from ground ring conductor to:
 - 1) Perimeter columns of metal building frame.
 - 2) Ground rod electrodes located as indicated.
 5. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
 - d. Provide ground access well for each electrode.
 6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
- F. Service-Supplied System Grounding:
 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
8. Provide bonding for interior metal air ducts.
9. Provide bonding for metal building frame where not used as a grounding electrode.

H. Isolated Ground System:

1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.
2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

I. Pole-Mounted Luminaires: Also comply with Section 26 56 00.**2.02 GROUNDING AND BONDING COMPONENTS****A. General Requirements:**

1. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in addition to requirements of Section 26 05 19:

1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.

- a. Exceptions:
 - 1) Use mechanical connectors for connections to electrodes at ground access wells.
- 3. Unless otherwise indicated, use exothermic welded connections for accessible connections.
 - a. Exceptions:
 - 1) Use exothermic welded connections for connections to metal building frame.
- 4. Manufacturers - Mechanical and Compression Connectors:
 - a. Advanced Lightning Technology (ALT): www.altfab.com.
 - b. Burndy: www.burndy.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- 5. Manufacturers - Exothermic Welded Connections:
 - a. Burndy: www.burndy.com.
 - b. Cadweld, a brand of Erico International Corporation: www.erico.com.
 - c. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Ground Bars:
 - 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 - 2. Size: As indicated.
 - 3. Holes for Connections: As indicated or as required for connections to be made.
 - 4. Manufacturers:
 - a. Advanced Lightning Technology (ALT): www.altfab.com.
 - b. Erico International Corporation: www.erico.com.
 - c. Harger Lightning & Grounding: www.harger.com.
 - d. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Ground Rod Electrodes:
 - 1. Comply with NEMA GR 1.
 - 2. Material: Copper-bonded (copper-clad) steel.
 - 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
 - 4. Manufacturers:
 - a. Advanced Lightning Technology (ALT): www.altfab.com.
 - b. Erico International Corporation: www.erico.com.
 - c. Galvan Industries, Inc: www.galvanelectrical.com.
 - d. Harger Lightning & Grounding: www.harger.com.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Ground Enhancement Material:
 - 1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.
 - 2. Resistivity: Not more than 20 ohm-cm in final installed form.
 - 3. Manufacturers:
 - a. Erico International Corporation: www.erico.com.
 - b. Harger Lightning & Grounding: www.harger.com.
 - c. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- G. Ground Access Wells:
 - 1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.

2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
 - a. Round Wells: Not less than 8 inches in diameter.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
4. Cover: Factory-identified by permanent means with word "GROUND".
5. Manufacturers:
 - a. Advanced Lightning Technology (ALT): www.altfab.com.
 - b. Erico International Corporation: www.erico.com.
 - c. Harger Lightning & Grounding: www.harger.com.
 - d. Thermoweld, a brand of Continental Industries, Inc: www.thermoweld.com.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 MANUFACTURERS

- A. Cooper Power Systems: www.cooperpower.com.
- B. Framatome Connectors International: www.fciconnect.com.
- C. Lightning Master Corporation: www.lightningmaster.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 CONNECTORS AND ACCESSORIES

- A. Mechanical Connectors: Bronze.
 1. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Wire: Stranded copper.
- C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify existing conditions prior to beginning work.
- E. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- D. Make grounding and bonding connections using specified connectors.
 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.

2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

- E. Identify grounding and bonding system components in accordance with Section 26 05 53.
- F. Provide bonding to meet requirements described in Quality Assurance.
- G. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing. Each of branch circuits and feeder circuits shall have dedicated equipment grounding conductor, sharing this conductor with other grounding conductors is not permitted.

3.03 FIELD QUALITY CONTROL

- A. Perform inspection in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA STD ATS except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- C. Section 26 05 34 - Conduit: Additional support and attachment requirements for conduits.
- D. Section 26 05 37 - Boxes: Additional support and attachment requirements for boxes.
- E. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- F. Section 26 56 00 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- D. MFMA-4 - Metal Framing Standards Publication.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- F. NFPA 70 - National Electrical Code.
- G. UL 5B - Strut-Type Channel Raceways and Fittings.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing:
 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
- D. Installer's Qualifications: Include evidence of compliance with specified requirements.
- E. Product Data: Provide manufacturer's catalog data for fastening systems.
- F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- D. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
- E. Installer Qualifications for Field-Welding: As specified in Section 05 50 00.
- F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

- B. Materials for Metal Fabricated Supports: Comply with Section 05 50 00.
- C. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
 - 3. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Erico International Corporation: www.erico.com.
 - c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - d. Thomas & Betts Corporation: www.tnb.com.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
 - 1. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Erico International Corporation: www.erico.com.
 - c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - d. Thomas & Betts Corporation: www.tnb.com.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Comply with MFMA-4.
 - 2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
 - 3. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
 - 5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
 - 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Thomas & Betts Corporation: www.tnb.com.
 - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- F. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch diameter.
 - c. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
 - e. Outlet Boxes: 1/4 inch diameter.
 - f. Luminaires: 1/4 inch diameter.
- G. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.

3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Powder-actuated fasteners are not permitted.
9. Hammer-driven anchors and fasteners are not permitted.
10. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

2.02 MANUFACTURERS

- A. Thomas & Betts Corporation: www.tnb.com.
- B. Threaded Rod Company: www.threadedrod.com.
- C. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 MATERIALS

- A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
- B. Supports: Fabricated of structural steel or formed steel members; galvanized.
- C. Anchors and Fasteners:
 1. Do not use powder-actuated anchors.
 2. Obtain permission from Architect before using powder-actuated anchors.
 3. Concrete Structural Elements: Use precast inserts.
 4. Steel Structural Elements: Use beam clamps.
 5. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
 6. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use hollow wall fasteners.
 7. Solid Masonry Walls: Use expansion anchors.
 8. Sheet Metal: Use sheet metal screws.
 9. Wood Elements: Use wood screws.
- D. Formed Steel Channel:
 1. Product: manufactured by [B-Line].
 2. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Conduit Support and Attachment: Also comply with Section 26 05 34.
- I. Box Support and Attachment: Also comply with Section 26 05 37.
- J. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00.
- K. Exterior Luminaire Support and Attachment: Also comply with Section 26 56 00.
- L. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- M. Secure fasteners according to manufacturer's recommended torque settings.
- N. Remove temporary supports.
- O. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 05 34
CONDUIT

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Galvanized steel rigid metal conduit (RMC).
- B. Flexible metal conduit (FMC).
- C. Liquidtight flexible metal conduit (LFMC).
- D. Electrical metallic tubing (EMT).
- E. Rigid polyvinyl chloride (PVC) conduit.
- F. Conduit fittings.
- G. Accessories.
- H. Conduit, fittings and conduit bodies.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 07 84 00 - Firestopping.
- C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.
- D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- E. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- F. Section 26 0553 - Identification for Electrical Systems.
- G. Section 26 05 37 - Boxes.
- H. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- I. Section 31 23 16 - Excavation.
- J. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
- C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A).
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).
- F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC).
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- H. NFPA 70 - National Electrical Code.
- I. UL 1 - Flexible Metal Conduit.
- J. UL 6 - Electrical Rigid Metal Conduit-Steel.
- K. UL 360 - Liquid-Tight Flexible Steel Conduit.
- L. UL 514B - Conduit, Tubing, and Cable Fittings.

- M. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- N. UL 797 - Electrical Metallic Tubing-Steel.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
 - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
 - 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Shop Drawings:
 - 1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
 - 2. Include proposed locations of roof penetrations and proposed methods for sealing.
- D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.
- E. Product Data: Provide for metallic conduit and flexible metal conduit.
- F. Samples of Materials Actually Delivered to Site:
 - 1. Two pieces each of conduit, 2 feet long.
- G. Project Record Documents: Accurately record actual routing of conduits larger than 2 inches.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
- B. Accept conduit on site. Inspect for damage.

- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Under Slab on Grade: Use rigid PVC conduit.
 - 2. Exterior, Direct-Buried: Use rigid PVC conduit.
 - 3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.
 - 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
 - 5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
- D. Embedded Within Concrete:
- E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit.
- F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).
- G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).
- H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit.
- J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
 - 1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
- K. Exposed, Exterior: Use galvanized steel rigid metal conduit.
- L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.
- M. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
 - 1. Maximum Length: 6 feet.
- N. Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit.
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 - 3. Maximum Length: 6 feet unless otherwise indicated.
 - 4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.
 - c. HVAC equipment.
- O. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.02 CONDUIT REQUIREMENTS

- A. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

- B. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
- C. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 3/4 inch (21 mm) trade size.
 - 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
 - 3. Control Circuits: 1/2 inch (16 mm) trade size.
 - 4. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.
 - 5. Underground, Interior: 3/4 inch (21 mm) trade size.
 - 6. Underground, Exterior: 1 inch (27 mm) trade size.
- D. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.allieddeg.com.
 - 2. Republic Conduit: www.republic-conduit.com.
 - 3. Wheatland Tube Company: www.wheatland.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 METAL CONDUIT

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedtube.com.
 - 2. Beck Manufacturing, Inc: www.beckmfg.com.
 - 3. Wheatland Tube Company: www.wheatland.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.05 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com.
 - 2. Electri-Flex Company: www.electriflex.com.
 - 3. International Metal Hose: www.metalhose.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Fittings with insulated bushing complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
- D. Description: Interlocked steel construction.
- E. Fittings: NEMA FB 1.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com.
 - 2. Electri-Flex Company: www.electriflex.com.
 - 3. International Metal Hose: www.metalhose.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Fittings with insulated bushing complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.

2.07 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com.
 - 2. Republic Conduit: www.republic-conduit.com.
 - 3. Wheatland Tube Company: www.wheatland.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Fittings with insulated bushings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.

4. Connectors and Couplings: Use compression (gland) or set-screw type.
 - a. Do not use indenter type connectors and couplings.
5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
6. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 1. Cantex Inc: www.cantexinc.com.
 2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com.
 3. JM Eagle: www.jmeagle.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
 1. Manufacturer: Same as manufacturer of conduit to be connected.
 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.09 ACCESSORIES

- A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- C. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- D. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
- E. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify routing and termination locations of conduit prior to rough-in.
- E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- E. Conduit Routing:
 1. Unless dimensioned, conduit routing indicated is diagrammatic.

2. When conduit destination is indicated and routing is not shown, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
5. Arrange conduit to maintain adequate headroom, clearances, and access.
6. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
7. Arrange conduit to provide no more than 150 feet between pull points.
8. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
9. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
10. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
11. Group parallel conduits in the same area together on a common rack.

F. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use of spring steel conduit clips for support of conduits is not permitted.
9. Use of wire for support of conduits is not permitted.
 - a. For securing conduits to studs in hollow stud walls.
 - b. For suspending conduits supported by spring steel conduit clips (only where specifically indicated or permitted).

G. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.

6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

H. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

I. Underground Installation:

1. Provide trenching and backfilling in accordance with Section 31 23 16.13.
2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 - b. Under Slab on Grade: 12 inches to bottom of slab.
3. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length.

J. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

K. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.

L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where conduits are subject to earth movement by settlement or frost.

M. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:

1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

N. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

O. Provide grounding and bonding in accordance with Section 26 05 26.

P. Identify conduits in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

3.06 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- B. Route conduit through roof openings for piping and ductwork wherever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation specified in Section roofing section.

END OF SECTION

SECTION 26 05 37
BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Wall and ceiling outlet boxes.
- D. Floor boxes.
- E. Pull and junction boxes.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 27 26 - Wiring Devices:
 - 1. Wall plates.
- E. Section 26 2716 - Electrical Cabinets and Enclosures.
- F. Section 26 2726 - Wiring Devices: Wall plates in finished areas, floor box service fittings, fire-rated poke-through fittings, and access floor boxes.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- E. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- G. NFPA 70 - National Electrical Code.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- J. UL 508A - Industrial Control Panels.
- K. UL 514A - Metallic Outlet Boxes.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
 - 4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.

5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Project Record Documents: Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use suitable concrete type boxes where flush-mounted in concrete.
 4. Use suitable masonry type boxes where flush-mounted in masonry walls.
 5. Use raised covers suitable for the type of wall construction and device configuration where required.
 6. Use shallow boxes where required by the type of wall construction.
 7. Do not use "through-wall" boxes designed for access from both sides of wall.
 8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
 12. Wall Plates: Comply with Section 26 27 26.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:

1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

2.02 MANUFACTURERS

- A. Appleton Electric: www.appletonelec.com.
- B. Steel City
- C. Substitutions: Reco, Inc. See Section 01 60 00 - Product Requirements.

2.03 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
 2. Concrete Ceiling Boxes: Concrete type.
- B. Nonmetallic Outlet Boxes: NEMA OS 2.
- C. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 26 2726.

2.04 FLOOR BOXES

- A. Floor Boxes: NEMA OS 1, fully adjustable, 4 inches deep.
- B. Material: Cast metal.
- C. Shape: Rectangular.
- D. Service Fittings: As specified in Section 26 2726.

2.05 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Hinged Enclosures: As specified in Section 26 2716.
- C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 1. Material: Galvanized cast iron; Cast Aluminum.
 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- D. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
 1. Material: Galvanized cast iron; Cast Aluminum.
 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
 3. Cover Legend: "ELECTRIC".

PART 3 EXECUTION

3.01 EXAMINATION

3.02

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify locations of floor boxes and outlets in offices and work areas prior to rough-in.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Box Supports:
 - 1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- E. Install boxes plumb and level.
- F. Flush-Mounted Boxes:
 - 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 - 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 - 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- G. Install boxes as required to preserve insulation integrity.
- H. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- I. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- J. Close unused box openings.
- K. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- L. Provide grounding and bonding in accordance with Section 26 05 26.
- M. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
- N. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.
- O. Coordinate installation of outlet boxes for equipment connected under Section 26 2717.
- P. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- Q. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.
 - 1. Adjust box locations up to 10 feet if required to accommodate intended purpose.
- R. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726.
- S. Maintain headroom and present neat mechanical appearance.
- T. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- U. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

- V. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- W. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- X. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- Y. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- Z. Use flush mounting outlet box in finished areas.
- AA. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- AB. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.
- AC. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- AD. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- AE. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- AF. Use adjustable steel channel fasteners for hung ceiling outlet box.
- AG. Do not fasten boxes to ceiling support wires.
- AH. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.
- AI. Use gang box where more than one device is mounted together. Do not use sectional box.
- AJ. Use gang box with plaster ring for single device outlets.
- AK. Use cast outlet box in exterior locations exposed to the weather and wet locations.
- AL. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
- AM. Set floor boxes level.
- AN. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.04 ADJUSTING

- A. Adjust floor boxes flush with finish flooring material.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused box openings.

3.05 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.06 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Warning signs and labels.
- F. Field-painted identification of conduit.

1.02 RELATED REQUIREMENTS

- A. Section 09 90 00 - Painting and Coating.
- B. Section 26 05 73 - Overcurrent Protective Device Coordination Study: Arc flash hazard warning labels.

1.03 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.
- C. NFPA 70 - National Electrical Code.
- D. UL 969 - Marking and Labeling Systems.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide catalog data for nameplates, labels, and markers.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.06 EXTRA MATERIALS

- A. See Section 01 6000 - Product Requirements for additional requirements.

PART 2 PRODUCTS**2.01 IDENTIFICATION REQUIREMENTS**

- A. Identification for Equipment:
 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 2. Arc Flash Hazard Warning Labels: Comply with Section 26 05 73.
- B. Identification for Conductors and Cables:
 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

2.02 MANUFACTURERS

- A. Brady Corporation: www.bradycorp.com.
- B. Seton Identification Products: www.seton.com/aec.
- C. HellermannTyton: www.hellermanntyton.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
 - 1. Materials:
 - 2. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
 - 1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - 2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Nameplates: Engraved three-layer laminated plastic, black letters on white background.
- D. Locations:
 - 1. Each electrical distribution and control equipment enclosure.
 - 2. Communication cabinets.
 - 3. Disconnect switches, and starters.
- E. Letter Size:
 - 1. Use 1/8 inch letters for identifying individual equipment and loads.
 - 2. Use 1/4 inch letters for identifying grouped equipment and loads.

2.04 WIRE AND CABLE MARKERS

- A. Manufacturers:
 - 1. Panduit Corp.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.
- H. Description: split sleeve type wire markers.
- I. Locations: Each conductor at panelboard gutters, pull boxes, outlet boxes, and junction boxes each load connection.
- J. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
 - 2. Control Circuits: Control wire number indicated on shop drawings.

2.05 VOLTAGE MARKERS

- A. Manufacturers: Panduit Corp

1. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Minimum Size:
 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- C. Legend:
 1. Markers for Voltage Identification: Highest voltage present.
 2. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
 - b. Other Systems: Type of service.
- D. Color: Black text on orange background unless otherwise indicated.
- E. Location: Furnish markers for each conduit longer than 6 feet.
- F. Spacing: 20 feet on center.
- G. Color:
 1. 480 Volt System: Brown.
 2. 208 Volt System: Yellow.
 3. Fire Alarm System: Red.
- H. Legend:
 1. 480 Volt System: brown.
 2. 208 Volt System: yellow.
 3. Fire Alarm System: red.

2.06 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 1. Materials:
 2. Minimum Size: 7 by 10 inches unless otherwise indicated.
- C. Warning Labels:
 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.
- B. Degrease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.

4. Elevated Equipment: Legible from the floor or working platform.
5. Interior Components: Legible from the point of access.
6. Conductors and Cables: Legible from the point of access.

- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

END OF SECTION

SECTION 26 05 73
OVERTCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Arc flash and shock risk assessment.
 - 1. Includes arc flash hazard warning labels.
- B. Short circuit study.
- C. Coordination study and analysis.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
 - 2. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Submit study reports prior to or concurrent with product submittals.
 - 2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.
- C. Scheduling:
 - 1. Arrange access to existing facility for data collection with Owner.
 - 2. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Study reports, stamped or sealed and signed by study preparer.
- C. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
 - 1. Identify modifications made in accordance with studies that:
 - a. Can be made at no additional cost to Owner.
 - b. As submitted will involve a change to the contract sum.
- D. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.
- E. Study Report: Submit protective device studies as specified, prior to submission of product data submittals or ordering or fabrication of protective devices.
 - 1. Include stamp or seal and signature of preparing engineer.
- F. Field quality control reports.

1.04 PROTECTIVE DEVICE STUDY

- A. Analyze the specific electrical and utilization equipment (according to NEC definition), the actual protective devices to be used, and the actual feeder lengths to be installed.
 - 1. Study Methodology: Comply with requirements and recommendations of NFPA 70, IEEE 399, and IEEE 242.
 - 2. Report: State the methodology and rationale employed in making each type of calculation; identify computer software package(s) used.

B. One-Line Diagrams: Prepare schematic drawing of electrical distribution system, with all electrical equipment and wiring to be protected by the protective devices; identify nodes on the diagrams for reference on report that includes:

1. Calculated fault impedance, X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at the main switchboard bus and all downstream devices containing protective devices.
2. Breaker and fuse ratings.
3. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
4. Identification of each bus, with voltage.
5. Conduit materials, feeder sizes, actual lengths, and X/R ratios.

C. Short Circuit Study: Calculate the fault impedance to determine available 3-phase short circuit and ground fault currents at each bus and piece of equipment during normal conditions, alternate operations, emergency power conditions, and other operations that could result in maximum fault conditions.

1. Show fault currents available at key points in the system down to a fault current of 7,000 A at 480 V and 208 V.
2. Include motor contributions in determining the momentary and interrupting ratings of the protective devices.
3. Report: Include all pertinent data used in calculations and for each device include:
 - a. Device identification.
 - b. Protective device.
 - c. Device rating.
 - d. Calculated short circuit current, asymmetrical and symmetrical, and ground fault current.

D. Coordination Study: Perform an organized time-current analysis of each protective device in series from the individual device back to the primary source, under normal conditions, alternate operations, and emergency power conditions.

1. Graphically illustrate that adequate time separation exists between series devices, including upstream primary device.
2. Plot the specific time-current characteristics of each protective device on log-log paper.
3. Organize plots so that all upstream devices are clearly depicted on one sheet.
4. Also show the following on curve plot sheets:
 - a. Device identification.
 - b. Voltage and current transformer ratios for curves.
 - c. 3-phase and 1-phase ANSI damage curves for each transformer.
 - d. No-damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum short circuit cutoff point.
 - h. Simple one-line diagram for the portion of the system that each curve plot illustrates.
 - i. Software report for each curve plot, labeled for identification.

E. Analysis: Determine ratings and settings of protective devices to minimize damage caused by a fault and so that the protective device closest to the fault will open first.

1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
2. Identify any equipment that is underrated as specified.
3. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve a change to the contract sum.

4. In all cases where adequate protection or coordination cannot be achieved at no extra cost to Owner, provide a discussion of alternatives and logical compromises for best achievable coordination.
- F. Protective Device Rating and Setting Chart: Summarize in tabular format the required characteristics for each protective device based on the analysis; include:
 1. Device identification.
 2. Relay CT ratios, tap, time dial, and instantaneous pickup.
 3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
 4. Fuse rating and type.
 5. Ground fault pickup and time delay.
 6. Input level and expected response time at two test points that are compatible with commonly available test equipment and the ratings of the protective device.
 7. Highlight all devices that as furnished by Contractor will not achieve required protection.

1.05 QUALITY ASSURANCE

- A. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
 1. Acceptable Software Products:
 - a. SKM Systems Analysis, Inc: www.skm.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Contractor Responsibility: Provide all project-related data needed by study preparer, including equipment, wire sizes, insulation types, conduit types, and actual circuit lengths.
- C. Owner's Responsibility: Provide data on relevant Owner power distribution equipment.

PART 2 PRODUCTS

2.01 ARC FLASH HAZARD WARNING LABELS

- A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
 1. Materials: Comply with Section 26 05 53.
 2. Minimum Size: 4 by 6 inches.
 3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
 - a. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
 - b. Include the following information:
 - 1) Arc flash boundary.
 - 2) Available incident energy and corresponding working distance.
 - 3) Nominal system voltage.

2.02 PROTECTIVE DEVICES

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install arc flash warning labels in accordance with Section 26 05 53.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Adjust equipment and protective devices for compliance with studies and recommended settings.

- D. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.
- E. Submit detailed reports indicating inspection and testing results, and final adjusted settings.

END OF SECTION

SECTION 26 09 19
ENCLOSED CONTACTORS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. General purpose contactors.
- B. Lighting contactors.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 28 13 - Fuses.

1.03 REFERENCE STANDARDS

- A. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
- B. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
- C. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
- D. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- E. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- F. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide dimensions, size, voltage ratings and current ratings.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Allen-Bradley/Rockwell Automation: www.ab.com.
- B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GENERAL PURPOSE CONTACTORS

- A. Description: NEMA ICS 2, AC general purpose magnetic contactor.

- B. Coil operating voltage: 120 volts, 60 Hertz.
- C. Poles: As required to match circuit configuration and control function.
- D. Enclosure: NEMA ICS 6, Type 1.
- E. Accessories:
 - 1. Selector Switch: ON/OFF/AUTOMATIC.
 - 2. Indicating Light: RED.
 - 3. Auxiliary Contacts: One, normally open.

2.03 LIGHTING CONTACTORS

- A. Description: NEMA ICS 2, magnetic lighting contactor.
- B. Configuration: Mechanically held, 3 wire control.
- C. Coil operating voltage: 120 volts, 60 Hertz.
- D. Poles: As required to match circuit configuration and control function.
- E. Contact Rating: Match branch circuit overcurrent protection, considering derating for continuous loads.
- F. Enclosure: NEMA ICS 6, Type 1.
- G. Accessories:
 - 1. Selector Switch: ON/OFF/AUTOMATIC.
 - 2. Indicating Light: RED.
 - 3. Auxiliary Contacts: One, normally open.

2.04 ACCESSORIES

- A. Auxiliary Contacts: NEMA ICS 2, 2 normally open contacts in addition to seal-in contact.
- B. Cover Mounted Pilot Devices: NEMA ICS 5, oiltight type.
- C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
- D. Pushbuttons: Lockable type.
- E. Indicating Lights: , LED type.
- F. Selector Switches: Rotary type.
- G. Relays: NEMA ICS 2, .
- H. Control Power Transformers: 120 volt secondary, 50 VA minimum, in each enclosed contactor. Provide fused primary and secondary, and bond unfused leg of secondary to enclosure.

2.05 DISCONNECTS

- A. Combination Contactors: Combine contactor with disconnect in common enclosure.
- B. Disconnects: Thermal magnetic circuit breaker with integral thermal and instantaneous magnetic trip in each pole; UL listed.
- C. Disconnects: Fusible switch assembly; NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate Class R fuses.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install enclosed contactors where indicated, in accordance with manufacturer's instructions.
- B. Install enclosed contactors plumb. Provide supports in accordance with Section 26 05 29.
- C. Height: 5 ft to operating handle.
- D. Provide fuses for fusible switches; refer to Section 26 28 13 for product requirements.

- E. Provide engraved plastic nameplates; refer to Section 26 0553 for product requirements and location.

3.02 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform applicable inspections and tests listed in NETA STD ATS, Section 7.16.1.

END OF SECTION

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Occupancy sensors.
- B. Time switches.
- C. In-wall interval timers.
- D. Outdoor photo controls.
- E. Daylighting controls.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 37 - Boxes.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 09 19 - Enclosed Contactors: Lighting contactors.
- E. Section 26 09 43 - Network Lighting Controls - Lutron.
- F. Section 26 27 26 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, fan speed controllers, and wall plates.
- G. Section 26 51 00 - Interior Lighting.
- H. Section 26 56 00 - Exterior Lighting.
- I. Section 01 91 00 - Commissioning
- J. Section 01 91 10 - Functional Testing Procedures
- K. Section 23 08 10 - Control Systems Commissioning

1.03 REFERENCE STANDARDS

- A. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NFPA 70 - National Electrical Code.
- F. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control.
- G. UL 916 - Energy Management Equipment.
- H. UL 917 - Clock-Operated Switches.
- I. UL 1472 - Solid-State Dimming Controls.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
 2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.

3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
- C. Shop Drawings:
 1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
 2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.
- D. Field Quality Control Reports.
- E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: Include detailed information on device programming and setup.
- G. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

- B. Provide five year manufacturer warranty for all occupancy sensors.
- C. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS

2.01 ALL LIGHTING CONTROL DEVICES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.
- C. Products for Switching of Electronic Fluorescent Ballasts: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

2.02 OCCUPANCY SENSORS

- A. Manufacturers:
 - 1. Hubbell Building Automation, Inc: www.hubbellautomation.com
 - 2. Lutron Electronics Company, Inc: www.lutron.com.
 - 3. Sensor Switch Inc: www.sensorswitch.com.
 - 4. WattStopper: www.wattstopper.com.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
 - 6. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. All Occupancy Sensors:
 - 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 - 2. Sensor Technology:
 - a. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
 - 3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
 - 4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
 - 5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
 - 6. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
 - 7. Sensitivity: Field adjustable.
 - 8. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
 - 9. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
 - 10. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on the drawings.
- C. Wall Switch Occupancy Sensors:
 - 1. All Wall Switch Occupancy Sensors:

- a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
- b. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
- c. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
- 2. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
 - a. Products:
 - 1) Hubbell Building Automation.
 - 2) Watt Stopper.
 - 3) Sensor switch.
 - 4) Substitutions: See Section 01 60 00 - Product Requirements.
- D. Wall Dimmer Occupancy Sensors:
 - 1. General Requirements:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated dimming control capability, and no leakage current to load in off mode.
 - b. Manual-Off Override Control Capability: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
 - c. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.
 - d. Provide field adjustable dimming preset for occupied state.
- E. Ceiling Mounted Occupancy Sensors:
 - 1. All Ceiling Mounted Occupancy Sensors:
 - a. Description: Low profile occupancy sensors designed for ceiling installation.
 - b. Unless otherwise indicated or required to control the load indicated on the drawings, provide low voltage units, for use with separate compatible accessory power packs.
 - c. Provide field selectable setting for disabling LED motion detector visual indicator.
 - d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
 - e. Finish: White unless otherwise indicated.
 - 2. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 2000 sqft at a mounting height of 9 feet, with a field of view of 360 degrees.
 - 1) Products:
 - (a) Hubbell Building Automation.
 - (b) Sensor Switch.
 - (c) Watt Stopper.
 - (d) Substitutions: See Section 01 60 00 - Product Requirements.
- F. Power Packs for Low Voltage Occupancy Sensors:
 - 1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
 - 2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.

3. Input Supply Voltage: Dual rated for 120/277 V ac.
4. Load Rating:
 - a. Incandescent Load: Not less than 15 A.
 - b. Fluorescent Load: Not less than 20 A.
 - c. Motor Load: Not less than 1 HP.

2.03 TIME SWITCHES

- A. Manufacturers:
 1. Intermatic, Inc: www.intermatic.com.
 2. Paragon, a brand of Invensys Controls: www.invensyscontrols.com.
 3. Tork, a division of NSI Industries LLC: www.tork.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
 5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. Digital Electronic Time Switches:
 1. Description: Factory-assembled solid state programmable controller with LCD display, listed and labeled as complying with UL 916 or UL 917.
 2. Program Capability:
 - a. Astronomic Time Switches: Single channel, capable of different schedule for each day of the week with additional holiday schedule available to override normal schedule for selected days and field-configurable astronomic feature to automatically adjust for seasonal changes in sunrise and sunset times.
 3. Schedule Capacity: Not less than 16 programmable on/off operations.
 4. Provide automatic daylight savings time and leap year compensation.
 5. Provide power outage backup to retain programming and maintain clock.
 6. Manual override: Capable of overriding current schedule both permanently and temporarily until next scheduled event.
 7. Provide remote photocell input with light level adjustment.
 8. Input Supply Voltage: As indicated on the drawings.
 9. Output Switch Contact Ratings:
 - a. Resistive Load: Not less than 30 A at 120-277 V ac.
 - b. Tungsten Load: Not less than 5 A at 120 V ac.
 - c. Inductive Load: Not less than 30 A at 120-277 V ac.
 - d. Ballast Load: Not less than 20 A at 120 V ac or 6 A at 277 V ac.
 - e. Motor Load: Not less than 1 HP at 120 V ac or 2 HP at 240 V ac.
 10. Provide lockable enclosure; environmental type per NEMA 250 as specified for the following installation locations:
 - a. Indoor clean, dry locations: Type 1.
- C. Electromechanical Time Switches:
 1. Description: Factory-assembled controller with motor-operated timing dial mechanism and adjustable trippers for setting on/off operations, listed and labeled as complying with UL 917.
 2. Program Capability:
 - a. 24-Hour Time Switches: With same schedule for each day of the week and skip-a-day feature to omit selected days.
 3. Schedule Capacity:
 - a. 24-Hour Time Switches: Accommodating not less than 12 pairs of selected on/off operations per day.
 4. Manual override: Capable of overriding current schedule both permanently and temporarily until next scheduled event.
 5. Input Supply Voltage: As indicated on the drawings.

6. Output Switch Configuration: As required to control the load indicated on the drawings.
7. Output Switch Configuration: SPST dry unpowered maintained contacts.
8. Output Switch Contact Ratings: As required to control the load indicated on the drawings.
9. Output Switch Contact Ratings:
 - a. Resistive Load: Not less than 40 A at 120-277 V ac.
 - b. Tungsten Load: Not less than 40 A at 120 V ac.
 - c. Inductive Load: Not less than 20 A at 120-277 V ac.
 - d. Motor Load: Not less than 1 HP at 120 V ac or 2 HP at 240 V ac.
10. Provide lockable enclosure; environmental type per NEMA 250 as specified for the following installation locations:

2.04 IN-WALL INTERVAL TIMERS

- A. Manufacturers:
 1. Intermatic, Inc: www.intermatic.com.
 2. Paragon, a brand of Invensys Controls: www.invensyscontrols.com.
 3. Tork, a division of NSI Industries LLC: www.tork.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
 5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. Digital Electronic In-Wall Interval Timers:
 1. Description: Factory-assembled solid state programmable controller with LCD display, suitable for mounting in standard wall box, and listed and labeled as complying with UL 916 or UL 917.
 2. Program Capability: Designed to turn load off at end of preset time interval.
 3. Time Interval: Field selectable range of presets available up to 12 hours.
 4. Provide field selectable audible and visual indication to warn that end of interval operation is about to turn off load.
 5. Provide power outage backup to retain programming and maintain clock.
 6. Manual override: Capable of both turning load off and resetting timer to original preset time interval.
 7. Switch Configuration: Suitable for use in either SPST or 3-way application.
 8. Contact Ratings:
 - a. Resistive Load: Not less than 20 A at 120-277 V ac.
 - b. Tungsten Load: Not less than 15 A at 120 V ac.
 - c. Ballast Load: Not less than 16 A at 120-277 V ac.
 - d. Motor Load: Not less than 1 HP at 120 V ac or 2 HP at 240 V ac.
- C. Spring Wound In-Wall Interval Timers:
 1. Description: Factory-assembled controller with mechanical spring wound timing mechanism requiring no electricity to operate; suitable for mounting in standard wall box; rotary control operator with matching wall plate factory marked with time interval units; listed and labeled as complying with UL 916 or UL 917.
 2. Program Capability: Designed to turn load off at end of preset time interval.
 3. Time Interval: User selectable from zero up to 15 minutes.
 4. Manual override: Provide hold feature to disable timer for constant on operation.
 5. Switch Configuration: SPST.
 6. Contact Ratings: As required to control the load indicated on the drawings.
 7. Contact Ratings:
 - a. Resistive Load: Not less than 20 A at 120 V ac or 10 A at 277 V ac.
 - b. Inductive Load: Not less than 20 A at 120 V ac or 10 A at 277 V ac.
 - c. Tungsten Load: Not less than 7 A at 120 V ac.
 - d. Motor Load: Not less than 1 HP at 120 V ac or 2 HP at 250 V ac.

2.05 OUTDOOR PHOTO CONTROLS

- A. Manufacturers:
 - 1. Intermatic, Inc: www.intermatic.com.
 - 2. Paragon, a brand of Invensys Controls: www.invensyscontrols.com.
 - 3. Tork, a division of NSI Industries LLC: www.tork.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Stem-Mounted Outdoor Photo Controls:
 - 1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
 - 2. Housing: Weatherproof, impact resistant polycarbonate.
 - 3. Photo Sensor: Cadmium sulfide.
 - 4. Provide external sliding shield for field adjustment of light level activation.
 - 5. Light Level Activation: 1 to 5 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
 - 6. Voltage: As required to control the load indicated on the drawings.
 - 7. Failure Mode: Fails to the on position.
 - 8. Load Rating: As required to control the load indicated on the drawings.
 - 9. Provide accessory wall-mounting bracket where indicated or as required to complete installation.

2.06 DAYLIGHTING CONTROLS

- A. Manufacturers:
 - 1. Hubbell Building Automation, Inc: www.hubbellautomation.com
 - 2. Sensor Switch Inc: www.sensorswitch.com.
 - 3. WattStopper: www.wattstopper.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
 - 5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. System Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls.
- C. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.
 - 1. Sensor Type: Filtered silicon photo diode.
 - 2. Sensor Range:
 - a. Indoor Photo Sensors: 5 to 100 footcandles.
 - 3. Finish: White unless otherwise indicated.
 - 4. Where wired sensors are indicated, wireless sensors are acceptable provided that all components and wiring modifications necessary for proper operation are included.
 - 5. Wireless Daylighting Control Photo Sensors:
 - a. RF Range: 30 feet through typical construction materials.
 - b. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 15, for Class B application.
 - c. Power: Battery-operated with minimum ten-year battery life.
- D. Dimming Photo Sensors: Photo sensor units with integral controller compatible with specified dimming ballasts, for direct continuous dimming of up to 50 ballasts.
- E. Daylighting Control Switching Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors, for switching of compatible power packs,

contactors, or relays in response to changes in measured light levels according to selected settings.

1. Operation: Unless otherwise indicated, load to be turned on when light level is below selected low set point and load to be turned off when light level is above selected high set point, with a no switching dead band between set points to prevent unwanted cycling.
2. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.
3. Control Capability:
 - a. Multi-Zone Switching Modules: Capable of controlling up to three separately programmable channels.

F. Daylighting Control Switching Modules for Wireless Sensors:

1. Description: Plenum rated, self-contained relay compatible with specified wireless photo sensors for switching of line voltage loads in response to changes in measured light levels according to selected settings.
2. Operation: Unless otherwise indicated, load to be turned on when light level is below selected low set point and load to be turned off when light level is above selected high set point, with a no switching dead band between set points to prevent unwanted cycling.
3. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.
4. Control Capability: Capable of controlling one programmable channel.
5. Input Supply Voltage: Dual rated for 120/277 V ac.
6. Load Rating:
 - a. General Purpose Load: Not less than 16 A.
 - b. Motor Load: Not less than 1/2 HP (120V) and 1.5 HP (277V).

G. Daylighting Control Dimming Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors and with specified dimming ballasts, for both continuous dimming of compatible dimming ballasts and switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.

1. Operation: Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.
2. Load to be turned off when available daylight is sufficient to fully dim the load, after the selected time delay.
3. Control Capability: Capable of controlling up to three separately programmable channels, with up to 50 ballasts per channel.
4. Dimming and Fade Rates: Adjustable from 5 to 60 seconds.
5. Cut-Off Delay: Selectable and adjustable from 0 to 20 minutes.

H. Power Packs for Low Voltage Daylighting Control Modules:

1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage daylighting control modules for switching of line voltage loads. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.
2. Input Supply Voltage: Dual rated for 120/277 V ac.
3. Load Ratings: As required to control the load indicated on the drawings.

I. Accessories:

1. Where indicated, provide compatible accessory wall switches for manual override control.
2. Where indicated, provide compatible accessory wireless controls for manual override control.
 - a. Products:
 - 1) Hubbell Biulding Automaiton.
 - 2) Sensor Switch.

3) Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
- F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of lighting control devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switch Occupancy Sensors: 48 inches above finished floor.
 - b. In-Wall Time Switches: 48 inches above finished floor.
 - c. In-Wall Interval Timers: 48 inches above finished floor.
 - 2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
 - 3. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
- C. Install lighting control devices in accordance with manufacturer's instructions.
- D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- E. Install lighting control devices plumb and level, and held securely in place.
- F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26.
- G. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- H. Identify lighting control devices in accordance with Section 26 05 53.
- I. Occupancy Sensor Locations:

1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect.
2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

J. Outdoor Photo Control Locations:

1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.

K. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.

L. Daylighting Control Photo Sensor Locations:

1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect.
2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.

M. Lamp Burn-In: Operate lamps at full output for minimum of 100 hours or prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

N. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.
- C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
- D. Test time switches to verify proper operation.
- E. Test outdoor photo controls to verify proper operation, including time delays where applicable.
- F. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.
- G. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
- C. Where indicated or as directed by Architect, install factory masking material or adjust integral blenders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

- D. Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Architect. Record settings in written report to be included with submittals.
- E. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.
- F. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 COMMISSIONING

- A. See Section 01 91 13 for commissioning requirements.

3.08 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. General purpose transformers.
- B. K-factor transformers rated for nonlinear loads.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 34 - Conduit: Flexible conduit connections.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 05 34 - Conduit: Flexible conduit connections.
- F. Section 26 24 16 - Panelboards.

1.03 REFERENCE STANDARDS

- A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers.
- B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers.
- C. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers.
- F. NEMA ST 1 - Specialty Transformers (Except General Purpose Type); National Electrical Manufacturers Association.
- G. NEMA ST 20 - Dry-Type Transformers for General Applications.
- H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- J. NFPA 70 - National Electrical Code.
- K. UL 506 - Standard for Specialty Transformers.
- L. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.
- B. NEMA TR-1/ANSI 57.12.51 and 57.12.50
- C. Federal Register - US department of Energy, Office of Energy Efficiency and Renewable Energy, 10 CFR Part 30, July 29, 2004. Energy Conservation Program for Commercial and Industrial Equipment, Energy Conservaiton Standards for Distribution Transformers, Proposed Rule.
- D. ANSI/ASHRAE/IESNA 90.1 - Energy Efficient Design on New Buildings Except Low- Rise Residential Buildings.

1. Transformer selection based on optimizing the combination of no-load, part-load, and full-load losses without compromising operational and reliability requirements for the building.
- E. ANSI/NEMA TP-1 - Guide for Determining Energy Efficiency for Distribution Transformers.
 1. For Reference only. US DOE does not consider NEMA TP-1 efficiency levels to reflect low life cycle cost.
- F. ANSI/NEMA TP-2 - Standard Test Method for Measuring Energy Consumption of Distribution Transformers.
- G. IEEE C57.110-1998 - IEEE Recommended Practice for establishing transformer capability when feeding nonsinusoidal load currents.
 1. Transformers losses increase in proportion to the mix of electronic equipment in the overall load fed from transformer.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
- C. Provide linear load efficiency data at 25 %, 35%, 50 %, 75 % , and 100 % full load.
 1. Vibration Isolators: Include attachment method and rated load and deflection.
- D. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.
- E. Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, core and coil material and rated temperature rise.
- F. Test Reports: Indicate loss data, efficiency at 0, 25, 50, 75 and 100 percent rated load, and sound level.
- G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- H. Maintenance Data: Include recommended maintenance procedures and intervals.
- I. Project Record Documents: Record actual locations of transformers.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- E. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.
 1. Greater than 10 kVA: 104 degrees F maximum.
 2. Less than 10 kVA: 77 degrees F maximum.
- B. Ambient Temperature: Do not exceed 86 degrees F average or 104 degrees F maximum measured during any 24 hour period during and after installation of transformers.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Electric; Square D Products; Premium 30 energy efficient: www.schneider-electric.us.
- B. Eaton Electrical/Cutler-Hammer: www.eatonelectrical.com.
- C. GE Industrial: www.geindustrial.com.
- D. Powersmiths International Corp.
- E. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ALL TRANSFORMERS

- A. Description: High performance, energy efficient, copper wound transformer with 30 % less losses than NEMA TP_1 . Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
 1. Altitude: Less than 3,300 feet.
 2. Ambient Temperature:
 - a. Greater than 10 kVA: Not exceeding 104 degrees F.
 - b. Less than 10 kVA: Not exceeding 77 degrees F.
 3. Ambient Temperature: Not exceeding 86 degrees F average or 104 degrees F maximum measured during any 24 hour period.
- C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.
- D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
- E. Basic Impulse Level: 10 kV for transformer up to 300 kva , 30 kv for transformer 300 kva and up.
- F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

- G. Isolate core and coil from enclosure using vibration-absorbing mounts.
- H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.03 GENERAL PURPOSE TRANSFORMERS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Primary Voltage: 480 volts delta, 3 phase.
- C. Secondary Voltage: 208Y/120 volts, 3 phase 4 wire.
- D. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. 15 kVA and Larger: Class 220 degrees C insulation system with 115 degrees C average winding temperature rise.
- E. Coil Conductors: Continuous copper windings with terminations brazed or welded.
- F. Winding Taps:
 - 1. Less than 3 kVA: None.
 - 2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
 - 3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
 - 4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.
- G. Energy Efficiency: DOE 2016 energy efficiency levels.
- H. Sound Levels: Low sound levels at least 5 db less than NEMA ST 20 standard sound levels.
- I. Mounting Provisions:
 - 1. Less than 15 kVA: Suitable for wall mounting.
 - 2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 3. Larger than 75 kVA: Suitable for floor mounting.
- J. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor clean, dry locations: Type 2.
 - 2. Construction: Heavy gage steel.
 - a. Less than 15 kVA: Totally enclosed, non-ventilated.
 - b. 15 kVA and Larger: Ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.
- K. Accessories:
 - 1. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.
- L. Primary Voltage: 480 volts, 3 phase.
- M. Secondary Voltage: 208Y/120 volts, 3 phase.
- N. Insulation system and average winding temperature rise for rated kVA as follows:
 - 1. 1-15 kVA: Class 185 with 115 degrees C rise, in a 40 C ambient setting.
 - 2. 16-500 kVA: Class 220 with 115 degrees C rise, in a 40 C ambient setting.
- O. Case Temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.
- P. Winding Taps:
 - 1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

2. Transformers 15 kVA and Larger: Two 2-1/2% full capacity taps above and below normal primary voltage.
- Q. Energy Standard
 1. Efficiency at 50% load is at least 0.9% higher than NEMA TP-1 for transformers up to 750 kVA.
- R. Basic Impulse Level: 30kV for transformers 300 kVA and larger.
- S. Basic Impulse Level: 10 kV
- T. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- U. Mounting:
 1. 1-15 kVA: Suitable for wall mounting.
 2. 16-75 kVA: Suitable for wall mounting.
 3. Larger than 75 kVA: Suitable for floor mounting.
- V. Coil Conductors: Continuous copper windings with terminations brazed or welded.
- W. Transformer Enclosure: NEMA ST 20.
 1. Type 1.
 2. Ventilated.
 3. Provide lifting eyes or brackets.
 4. All terminals, including those for changing taps, must be readily accessible by removing front cover plates.
- X. Isolate core and coil from enclosure using vibration-absorbing mounts.
- Y. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.04 K-FACTOR TRANSFORMERS RATED FOR NONLINEAR LOADS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 1561, and designed to supply nonlinear loads to the degree designated by the UL defined K-factor; ratings as indicated on the drawings.
- B. Primary Voltage: 480 volts delta, 3 phase.
- C. Secondary Voltage: 208Y/120 volts, 3 phase.
- D. K-factor Rating: K-4, or higher.
- E. Insulation System and Allowable Average Winding Temperature Rise: Class 220 degrees C insulation system with 115 degrees C average winding temperature rise.
- F. Coil Conductors: Continuous copper windings with terminations brazed or welded. Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies. Size secondary neutral conductor at twice the secondary phase conductor ampacity.
- G. Winding Taps: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
- H. Neutral Bus: Sized to accommodate twice the rated secondary current.
- I. Energy Efficiency: Comply with DOE 2016 requirements.
- J. Sound Levels: Low sound levels at least 5 db less than NEMA ST 20 standard sound levels.
- K. Mounting Provisions:
 1. Up to 75 kVA: Suitable for wall, floor, or trapeze mounting.
 2. Larger than 75 kVA: Suitable for floor mounting.

- L. Electrostatic Shield: Provide grounded copper electrostatic shield between primary and secondary windings to attenuate electrical noise.
- M. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor clean, dry locations: Type 2.
 - 2. Construction: Steel, ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.
- N. Accessories:
 - 1. Mounting Brackets: Provide manufacturer's standard brackets.
 - 2. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.05 SHIELDED TRANSFORMERS

- A. Description: Self-cooled, two winding, shielded isolation transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Primary Voltage: 480 volts delta, 3 phase.
- C. Secondary Voltage: 208Y/120 volts, 3 phase.
- D. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
 - 2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.
- E. Coil Conductors: Continuous copper windings with terminations brazed or welded.
- F. Winding Taps:
 - 1. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
- G. Energy Efficiency: Comply with DOE 2016 requirements.
- H. Sound Levels: Low sound levels at least 5 db less than NEMA ST 20 standard sound levels.
- I. Winding Shield: Electrostatic, with separate insulated grounding connection.
- J. Mounting Provisions:
 - 1. Less than 15 kVA: Suitable for wall mounting.
 - 2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 3. Larger than 75 kVA: Suitable for floor mounting.
- K. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 2. Construction: Steel.
 - a. Less than 15 kVA: Totally enclosed, non-ventilated.
 - b. 15 kVA and Larger: Ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.

2.06 SOURCE QUALITY CONTROL

- A. Factory test transformers according to NEMA ST 20.
- B. Production test each unit according to NEMA ST 20.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.
- C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install transformers in accordance with manufacturer's instructions.
- C. Install transformers in accordance with NECA 409 and IEEE C57.94.
- D. Use flexible conduit, under the provisions of Section 26 05 34, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.
- F. Set transformers plumb and level.
- G. Use flexible conduit, under the provisions of Section 26 0534, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- H. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.
- I. Mount floor-mounted transformers on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.
- J. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.
- K. Mount floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- L. Mount trapeze-mounted transformers as indicated.
- M. Provide seismic restraints.
- N. Provide grounding and bonding in accordance with Section 26 05 26.
- O. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.
- P. Where not factory-installed, install lugs sized as required for termination of conductors as shown on the drawings.
- Q. Identify transformers in accordance with Section 26 05 53.
- R. Install transformer identification nameplate in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.
- C. Inspect and test in accordance with NETA STD ATS, except Section 4.
- D. Perform inspections and tests listed in NETA STD ATS, Section 7.2.1.1. In addition to the basic requirements of Section 7.2, include the following:

1. Perform turns ratio tests at all tap positions.
2. Verification that as-left tap connections are as specified.
3. Perform excitation-current tests on each phase.
4. Measure the resistance of each winding at each tap connection.
5. Overpotential test on all high- and low-voltage windings-to-ground.

3.04 ADJUSTING

- A. Measure primary and secondary voltages and make appropriate tap adjustments.
- B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from transformer components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 24 13
SWITCHBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Switchboards.
- B. Overcurrent protective devices for switchboards.
- C. Switchboard accessories.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for supporting foundations and pads.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 05 73 - Overcurrent Protective Device Coordination Study: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- F. Section 26 27 01 - Electrical Service Entrance.
- G. Section 26 28 13 - Fuses.
- H. Section 26 43 00 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- B. ANSI C12.1 - American National Standard Code for Electricity Metering.
- C. ANSI C39.1 - American National Standard Requirements for Electrical Analog Indicating Instruments; 1981 (R1992).
- D. IEC 60051-1 - Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories - Part 1: Definitions and General Requirements Common To All Parts;.
- E. IEC 60051-2 - Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories - Part 2: Special Requirements for Ammeters and Voltmeters.
- F. IEEE C12.1 - American National Standard Code for Electricity Metering; Institute of Electrical and Electronic Engineers; 1988.
- G. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers.
- H. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- I. NECA 400 - Standard for Installing and Maintaining Switchboards.
- J. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- K. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- L. NEMA PB 2 - Deadfront Distribution Switchboards.
- M. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.
- N. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- O. NFPA 70 - National Electrical Code.
- P. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

- Q. UL 891 - Switchboards.
- R. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
 - 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Service Entrance Switchboards:
 - 1. Coordinate with Utility Company to provide switchboards with suitable provisions for electrical service and utility metering, where applicable.
 - 2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
 - 3. Obtain Utility Company approval of switchboard prior to fabrication.
 - 4. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.
 - 2. Include wiring diagrams showing all factory and field connections.
 - 3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 - 4. Include documentation of listed series ratings.
 - 5. Include documentation demonstrating selective coordination.
- D. Service Entrance Switchboards: Include documentation of Utility Company approval of switchboard.
- E. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
- F. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; and switchboard instrument details.
- G. Test Reports: Indicate results of factory production tests.

- H. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- I. Project Record Documents: Record actual locations of switchboards.
- J. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
- K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Enclosure Keys: Two of each different key.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.
- B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.
- C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.
- E. Deliver in 48 inch maximum width shipping splits, individually wrapped for protection and mounted on shipping skids.
- F. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- G. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Switchboards - Basis of Design: Schneider Electric co. QED power style switchboard.
- B. Switchboards - Other Acceptable Manufacturers:
 - 1. Eaton Corporation: www.eaton.com.
 - 2. General Electric Company: www.geindustrial.com.
- C. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Siemens Industry, Inc: www.usa.siemens.com.

- E. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
- F. Schneider Electric; Square D Products: www.schneider-electric.us.
- G. Substitutions: See Section 01 60 00 - Product Requirements.
- H. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- I. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 SWITCHBOARDS

- A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.
- D. Front-Connected Switchboards:
 1. Main Device(s): Individually-mounted.
 2. Feeder Devices: Panel/group-mounted.
 3. Arrangement: Front accessible only (not rear accessible), rear aligned.
 4. Gutter Access: Bolted covers.
 5. Basis of Design: Schneider Electric QED power style switchboard.
- E. Service Conditions:
 1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
 - a. Altitude: Less than 6,600 feet.
 - b. Ambient Temperature:
 - 1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.
 2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
 - a. Altitude: 1000 feet.
 - b. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- F. Short Circuit Current Rating:
 1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 2. Minimum Rating: 65,000 rms symmetrical amperes.
 3. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 4. Label equipment utilizing series ratings as required by NFPA 70.
- G. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- H. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

- I. Bussing: Sized in accordance with UL 891 temperature rise requirements.
 - 1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
 - 2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 - 4. Phase and Neutral Bus Material: Copper.
 - 5. Ground Bus Material: Copper.
- J. Conductor Terminations: Suitable for use with the conductors to be installed.
 - 1. Line Conductor Terminations:
 - a. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 - b. Main and Neutral Lug Type: Mechanical.
 - 2. Load Conductor Terminations:
 - a. Lug Material: Copper, suitable for terminating copper conductors only.
 - b. Lug Type:
 - 1) Provide mechanical lugs unless otherwise indicated.
 - 2) Provide compression lugs where indicated.
- K. Enclosures:
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).
 - 2. Finish: Manufacturer's standard unless otherwise indicated.
- L. Future Provisions:
 - 1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
 - 2. Arrange and equip through bus and ground bus to accommodate future installation of additional switchboard sections.
- M. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list switchboards as a complete assembly including surge protective device.
- N. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
 - 1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
 - 2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
 - a. Use zero sequence or residual ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
- O. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.
- P. Owner Metering:
 - 1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
 - 2. Basis of Design: ION 7350.
 - 3. Measured Parameters:

- a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
- b. Current (Amps): For each phase and neutral.
- c. Frequency (Hz).
- d. Real power (kW): For each phase, 3-phase total.
- e. Reactive power (kVAR): For each phase, 3-phase total.
- f. Apparent power (kVA): For each phase, 3-phase total.
- g. Power factor.
- h. Current demand.
- i. Power demand: Real, reactive, and apparent.
- 4. Meter Accuracy: Plus/minus 1.0 percent.
- 5. Features:
 - a. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
 - b. Remote monitoring capability via PC.

Q. Instrument Transformers:

- 1. Comply with IEEE C57.13.
- 2. Select suitable ratio, burden, and accuracy as required for connected devices.
- 3. Current Transformers: Connect secondaries to shorting terminal blocks.
- 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

R. Description: NEMA PB 2 switchboard with electrical ratings and configurations as indicated and specified.

S. Ratings:

- 1. Voltage: 120/208; 277/480 volts.
- 2. Configuration: Three phase, four wire, grounded.
- 3. Main Bus: 2000 amps. 277/480 v, 2000 amps, 208/120v .
- 4. Integrated Equipment Rating: 100000 rms amperes symmetrical.

T. Main Section Devices: Individually mounted and compartmented.

U. Distribution Section Devices: _Group mounted- double row sections.

V. Bus Material: Copper with tin plating, standard size.

W. Bus Connections: Bolted, accessible from front for maintenance.

X. Fully insulate load side bus bars

Y. Ground Bus: Extend length of switchboard.

Z. Insulated Ground Bus: Extend length of switchboard.

AA. Molded Case Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole.

- 1. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
- 2. Include shunt trip where indicated.
- 3. Circuit Breakers 1- 400amp and up shall be provided with field repalceable trip unit.
- 4. All Feeder breakers in 208/120v switchboard shall be series rated for min. of 65 kAIC with 1-pole circuit breakers in all panelboards. All feeder breakers in 480y/277v ,3ph4w switchboard shall be series rated for min. of 65 KAIC.

AB. Solid-State Molded Case Circuit Breakers: With electronic sensing, timing and tripping circuits for adjustable current settings; UL listed.

- 1. Ground fault trip, ground fault sensing integral with circuit breaker.
- 2. Instantaneous trip.
- 3. Adjustable short time/ long time trip.
- 4. Stationary mounting.
- 5. Include shunt trip where indicated.

- AC. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials and sizes indicated.
- AD. Ground Fault Sensor: Zero sequence type.
- AE. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches. Max time delay shall be one second for ground fault currents equal to or greater than 3000 amps.
- AF. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.
- AG. Enclosure: Type _NEMA 1-Indoors.
 - 1. Align sections at front and rear.
 - 2. Switchboard Height: 91.5 inches, excluding floor sills, lifting members and pull boxes.
 - 3. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
 - 4. Structure: Free standing, self supporting, totally front accessible.

2.03 OVERCURRENT PROTECTIVE DEVICES

- A. Circuit Breakers:
 - 1. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
 - 2. Molded Case Circuit Breakers:
 - a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 1) Provide thermal magnetic circuit breakers unless otherwise indicated.
 - 2) Provide electronic trip circuit breakers where indicated.
 - b. Minimum Interrupting Capacity:
 - 1) 14000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 21000 rms symmetrical amperes at 480 VAC.
 - c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1) Provide the following field-adjustable trip response settings:
 - (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - (b) Long time delay.
 - (c) Short time pickup and delay.
 - (d) Instantaneous pickup.
 - (e) Ground fault pickup and delay where ground fault protection is indicated.

- e. Provide the following features and accessories where indicated or where required to complete installation:
 - 1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

2.04 SURGE PROTECTIVE DEVICES

- A. See Section for factory-installed, internally mounted surge protective devices. List and label switchboards containing surge protective devices as a complete assembly including surge protective device.

2.05 POWER METERS

- A. Manufacturers:
 - 1. SQ D ION 7350 or approved equal.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Watt-Hour Meters and Wattmeters: ANSI C12.1, three phase induction type with two stators, each with current and potential coil, rated 5 amperes and 120 volts at 60 Hertz.
 - 1. Meter suitable for connection to 3- and 4-wire circuits.
 - 2. Potential indicating lamps.
 - 3. Adjustments for light and full load, phase balance, and power factor.
 - 4. Digital register.
 - 5. Integral demand indicator.
 - 6. Ratchets to prevent reverse rotation.
 - 7. Removable meter with draw-out test plug.
 - 8. Semi-flush mounted case with matching cover.
 - 9. BACnet gateway to provide connection to building automation system.
- C. Provide meters with appropriate multiplier tags.

2.06 METERING TRANSFORMERS

- A. Manufacturers:
 - 1. Square D or equal.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Current Transformers: IEEE C57.13, 5 ampere secondary, wound; bushing; bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
- C. Potential Transformers: IEEE C57.13, 120 volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.07 SOURCE QUALITY CONTROL

- A. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:
 - 1. Dielectric tests.
 - 2. Mechanical operation tests.
 - 3. Grounding of instrument transformer cases test.
 - 4. Electrical operation and control wiring tests, including polarity and sequence tests.
 - 5. Ground-fault sensing equipment test.
- B. Shop inspect and test switchboard according to NEMA PB 2.
- C. Make completed switchboard available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least 7 days before inspection is allowed.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive switchboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide concrete housekeeping pad under the provisions of Section .
- B. Verify that field measurements are as instructed by manufacturer.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.
- C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.
- D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.
- E. Provide required support and attachment components in accordance with Section 26 05 29.
- F. Install switchboards plumb and level.
- G. Unless otherwise indicated, mount switchboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.
- H. Provide grounding and bonding in accordance with Section 26 05 26.
- I. Install all field-installed devices, components, and accessories.
- J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73.
- L. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- M. Provide filler plates to cover unused spaces in switchboards.
- N. Identify switchboards in accordance with Section 26 05 53.
- O. Install switchboard in locations shown on drawings, according to NEMA PB 2.1.
- P. Install in a neat and workmanlike manner, as specified in NECA 400.
- Q. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
- R. Identify switchboards in accordance with Section 26 05 53.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- C. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.

- D. Perform field inspection and testing in accordance with Section .
- E. Inspect and test in accordance with NETA STD ATS, except Section 4.
- F. Perform inspections and tests listed in NETA STD ATS, Section 7.1.
- G. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 225 amperes. Tests listed as optional are not required.
- H. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
 - 1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.
- I. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.
- J. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10.
- K. Test shunt trips to verify proper operation.
- L. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.05 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of switchboard covers and doors.
- C. Adjust all operating mechanisms for free mechanical movement.
- D. Tighten bolted bus connections in accordance with manufacturer's instructions.
- E. Adjust circuit breaker trip and time delay settings to values indicated.
- F. Adjust circuit breaker trip and time delay settings to values as instructed by Architect.

3.06 CLEANING

- A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
- B. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.
- C. Touch up scratched or marred surfaces to match original finish.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

3.08 PROTECTION

- A. Protect installed switchboards from subsequent construction operations.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 05 73 - Overcurrent Protective Device Coordination Study: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- F. Section 26 22 00 - Low-Voltage Transformers: Small power centers with integral primary breaker, transformer, and panelboard.
- G. Section 26 28 13 - Fuses: Fuses for fusible switches and spare fuse cabinets.
- H. Section 26 43 00 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
- F. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- G. NEMA PB 1 - Panelboards.
- H. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- J. NFPA 70 - National Electrical Code.
- K. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- L. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- M. UL 67 - Panelboards.
- N. UL 98 - Enclosed and Dead-Front Switches.
- O. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- P. UL 869A - Reference Standard for Service Equipment.
- Q. UL 943 - Ground-Fault Circuit-Interrupters.

R. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include wiring diagrams showing all factory and field connections.
 - 2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Panelboard Keys: Two of each different key.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
 - 1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

1.09 MAINTENANCE MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.
- B. Furnish two of each panelboard key.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
- B. General Electric Company: www.geindustrial.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ALL PANELBOARDS

- A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.

2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
3. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.
5. Metal frame for type written directory
- 6.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Panelboard Contactors: Where panelboard contactors are indicated, provide electrically operated, mechanically held magnetic contactor complying with NEMA ICS 2.

1. Ampere Rating: Not less than ampere rating of panelboard bus.
2. Short Circuit Current Rating: Not less than the panelboard short circuit current rating.
3. Coil Voltage: As required for connection to control system indicated.

L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.

M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.03 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Products:

1. SQ D .
2. General Electric.
3. Eaton Cutler Hammer.
4. Substitutions: See Section 01 60 00 - Product Requirements.

C. Conductor Terminations:

1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Mechanical.

D. Bussing:

1. Phase and Neutral Bus Material: Copper.
2. Ground Bus Material: Copper.

- E. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
 - 2. Provide thermal magnetic circuit breakers unless otherwise indicated.
 - 3. Provide electronic trip circuit breakers where indicated.
- F. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.
 - 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable continuous hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 3. Provide metal circuit directory holder mounted on inside of door.
- G. Manufacturers:
 - 1. SQ.D or Equal.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- H. Description: NEMA PB 1, circuit breaker type.
- I. Service Conditions:
 - 1. Altitude: 1000 feet.
 - 2. Temperature: 55 degrees F.
- J. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard.
- K. Minimum integrated short circuit rating: As indicated.
 - 1. 240 Volt Panelboards: 14,000 amperes rms symmetrical (minimum).
 - 2. 480 Volt Panelboards: 21,000 amperes rms symmetrical (minimum).
- L. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.
- M. Molded Case Circuit Breakers with Current Limiters: With replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole; UL listed.
- N. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.
- O. Enclosure: NEMA PB 1, Type 1, 5 3/4" deep, 20" wide, cabinet box. With continued hinge and lock.
- P. Cabinet Front: Surface type, fastened with , hinged door with flush lock, finished in manufacturer's standard gray enamel.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Products:
 - 1. SQD.
 - 2. General Electric.
 - 3. Eaton Cutler Hammer.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 - 2. Main and Neutral Lug Type: Mechanical.
- D. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.

2. Phase and Neutral Bus Material: Copper.
3. Ground Bus Material: Copper.

E. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

F. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable continuous hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide metal circuit directory holder mounted on inside of door.

G. Manufacturers:

1. SQ.D or Equal.
2. Substitutions: See Section 01 60 00 - Product Requirements.

H. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

I. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard; provide insulated ground bus where scheduled.

J. Minimum Integrated Short Circuit Rating: As indicated.

1. 240 Volt Panelboards: 14,000 amperes rms symmetrical (minimum).
2. 480 Volt Panelboards: 21,000 amperes rms symmetrical (minimum).

K. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, bolt-on type, with common trip handle for all poles; UL listed.

1. Type SWD for lighting circuits.
2. Type HACR for air conditioning equipment circuits.
3. Class A ground fault interrupter circuit breakers where scheduled.
4. Do not use tandem circuit breakers, or miniature circuit breakers.

L. Enclosure: NEMA PB 1, Type 1.

M. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards, 20 inches wide for 480 volt panelboards.

N. Cabinet Front: Flush or Surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 14000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 21000 rms symmetrical amperes at 480 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Copper, suitable for terminating copper conductors only.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - b. Provide interchangeable trip units where indicated.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following field-adjustable trip response settings:
 - 1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - 2) Long time delay.
 - 3) Short time pickup and delay.
 - 4) Instantaneous pickup.
 - 5) Ground fault pickup and delay where ground fault protection is indicated.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
 - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
9. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
10. Do not use tandem circuit breakers.
11. Do not use handle ties in lieu of multi-pole circuit breakers.

2.06 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 29.
- E. Install panelboards plumb.
- F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

- G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- H. Mount floor-mounted power distribution panelboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.
- I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- J. Provide grounding and bonding in accordance with Section 26 05 26.
 - 1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
 - 2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.
- K. Install all field-installed branch devices, components, and accessories.
- L. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.
- M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- N. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.
- O. Install panelboards plumb. Install recessed panelboards flush with wall finishes, where installed surface mounted secure or anchor panelboard to brick or cinder block wall.
- P. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- Q. Provide filler plates to cover unused spaces in panelboards.
- R. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
 - 1. Emergency and night lighting circuits.
 - 2. Fire detection and alarm circuits.
 - 3. Communications equipment circuits.
 - 4. Intrusion detection and access control system circuits.
 - 5. Video surveillance system circuits.
- S. Identify panelboards in accordance with Section 26 05 53.
- T. Provide computer-generated circuit directory for each lighting and appliance panelboard and each power distribution panelboard provided with a door, clearly and specifically indicating the loads served. Identify spares and spaces.
- U. Provide identification nameplate for each panelboard in accordance with Section 26 0553.
- V. Provide arc flash warning labels in accordance with NFPA 70.
- W. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
 - 1. Minimum spare conduits: 5 empty 1 inch.
- X. Ground and bond panelboard enclosure according to Section 26 0526.

3.03 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Perform field inspection and testing in accordance with Section 01 4000.
- C. Inspect and test in accordance with NETA STD ATS, except Section 4.
- D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

- E. Test GFCI circuit breakers to verify proper operation.
- F. Test shunt trips to verify proper operation.
- G. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.
- H. Correct deficiencies and replace damaged or defective panelboards or associated components.
- I. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 27 01
ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Service racks.
- B. Metering transformer cabinets.
- C. Meter bases.

1.02 RELATED REQUIREMENTS

- A. Section 26 2413 - Switchboards: Metering transformer compartment.
- B. Section 26 0914 - Electrical Power Monitoring: Electric meters.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SYSTEM DESCRIPTION

- A. System Characteristics: 480Y/277 volts, three phase, four-wire, 60 Hertz.
- B. Service Entrance:

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week prior to commencing work of this section. Review service entrance requirements and details with Utility Company representative.

1.06 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide ratings and dimensions of transformer cabinets and meter bases.
- C. Submit utility company-prepared drawings.

1.07 QUALITY ASSURANCE

- A. Utility Company: City of Seaford dept of Electric
- B. Perform work in accordance with utility company written requirements and NFPA 70.
 - 1. Maintain one copy of each document on site.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.08 PRE-INSTALLATION MEETING

- A. Convene one week prior to commencing work of this section. Review service entrance requirements and details with Utility Company representative.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. GE Industrial: www.geindustrial.com.
- B. Milbank Manufacturing: www.milbankmfg.com.
- C. Square D: www.squared.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS

- A. Metering Transformer Cabinets: Sheet metal cabinet with hinged door, conforming to utility company requirements, with provisions for locking and sealing.
 - 1. Size: As required by utility.
- B. Meter Base: Furnished by utility company.
- C. Utility Transformer Pad: sized as indicated on drawings or size as required by Delmarva Power.
- D. Other Components: As required by utility company.

PART 3 EXECUTION**3.01 PREPARATION**

- A. Arrange with utility company to obtain permanent electric service to the Project.
- B. Verify that field measurements are as indicated on utility company drawings.

3.02 INSTALLATION

- A. Install service rack, transformer pad, metering transformer cabinets, and meter base as required by utility company.
- B. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

END OF SECTION

SECTION 26 27 17
EQUIPMENT WIRING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 34 - Conduit.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- C. Section 26 05 37 - Boxes.
- D. Section 26 27 26 - Wiring Devices.

1.03 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices.
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- C. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Determine connection locations and requirements.
- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Conform to NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
 - 4. Product:
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.

- B. Disconnect Switches: As specified in Section and in individual equipment sections.
- C. Wiring Devices: As specified in Section 26 27 26.
- D. Flexible Conduit: As specified in Section 26 05 34.
- E. Wire and Cable: As specified in Section 26 05 19.
- F. Boxes: As specified in Section 26 05 37.

2.02 EQUIPMENT CONNECTIONS

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
- J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates.
- E. Floor box service fittings.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 35 - Surface Raceways: Surface raceway systems, including multioutlet assemblies.
- D. Section 26 05 37 - Boxes.
- E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 09 23 - Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors, in-wall time switches, and in-wall interval timers.
- G. Section 26 27 17 - Equipment Wiring: Cords and plugs for equipment.
- H. Section 26 29 13 - Enclosed Controllers: Manual motor starters and horsepower rated motor-starting switches without overload protection.
- I. Section 27 10 05 - Structured Cabling for Voice and Data - Inside-Plant: Voice and data jacks.

1.03 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices.
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- G. NFPA 70 - National Electrical Code.
- H. UL 20 - General-Use Snap Switches.
- I. UL 498 - Attachment Plugs and Receptacles.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices.
- K. UL 943 - Ground-Fault Circuit-Interrupters.
- L. UL 1472 - Solid-State Dimming Controls.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.

2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install wiring devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Operation and Maintenance Data:
 1. GFCI Receptacles: Include information on status indicators.
- E. Project Record Documents: Record actual installed locations of wiring devices.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 2. Extra Wall Plates: One of each style, size, and finish.
 3. Extra Flush Floor Service Fittings: Two of each type.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

1.08 EXTRA MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.
- B. Furnish two of each style, size, and finish wall plate.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hubbell Incorporated; : www.hubbell-wiring.com.

- B. Leviton Manufacturing Company, Inc; : www.leviton.com.
- C. Lutron Electronics Company, Inc: www.lutron.com.
- D. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us
- E. Cooper Wiring Devices: www.cooperwiringdevices.com.
- F. Leviton Manufacturing, Inc: www.leviton.com.
- G. Substitutions: See Section 01 60 00 - Product Requirements.
- H. Source Limitations: Where possible, for each type of wiring device furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFI receptacles with specified weatherproof covers for all receptacles installed outdoors or in damp or wet locations.
- D. Provide GFI protection for all receptacles installed within 6 feet of sinks.
- E. Provide GFCI protection for receptacles serving electric drinking fountains.
- F. Unless noted otherwise, do not use combination switch/receptacle devices.
- G. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.03 ALL WIRING DEVICES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.04 WALL SWITCHES

- A. Manufacturers:
 - 1. Hubbell Incorporated; : www.hubbell-wiring.com.
 - 2. Leviton Manufacturing Company, Inc; : www.leviton.com.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- D. Wall Switches: Heavy Duty, AC only general-use snap switch, complying with NEMA WD 6 and WD 1.
 - 1. Body and Handle: Black plastic with toggle handle.
 - 2. Ratings:
 - a. Voltage: 120 - 277 volts, AC.
 - b. Current: 20 amperes.
 - 3. Ratings: Match branch circuit and load characteristics.
- E. Switch Types: Single pole, double pole, 3-way, and 4-way.

2.05 WALL DIMMERS

- A. Manufacturers:
 - 1. Leviton Manufacturing Company, Inc; _____: www.leviton.com.
 - 2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. All Wall Dimmers: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- C. Control: Slide control type with separate on/off switch.

2.06 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Incorporated; : www.hubbell-wiring.com.
 - 2. Leviton Manufacturing Company, Inc; : www.leviton.com.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
 - 1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 - a. Products:
 - 1) Hubbell Wiring Devices.
 - 2) Leviton.
 - 3) Pass & Seymour.
 - 4) Substitutions: See Section 01 60 00 - Product Requirements.
- D. GFI Receptacles:
 - 1. All GFI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and list as complying with UL 943, class A.
 - 2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
- E. Receptacles: Heavy duty, complying with NEMA WD 6 and WD 1.
 - 1. Device Body: Black plastic.
 - 2. Configuration: NEMA WD 6, type as specified and indicated.
- F. Convenience Receptacles: Type 5 - 20.
- G. Single Convenience Receptacles.
- H. Duplex Convenience Receptacles.
- I. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.07 TELEPHONE JACKS

- A. Product: AMP manufacturing

B. Substitutions: See Section 01 60 00 - Product Requirements.

2.08 WALL PLATES

- A. Manufacturers:
 - 1. Hubbell Incorporated; : www.hubbell-wiring.com.
 - 2. Leviton Manufacturing Company, Inc; : www.leviton.com.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. All Wall Plates: Comply with UL 514D.
 - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Size: Standard; .
 - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- E. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.
- F. Decorative Cover Plates: stainless steel.
- G. Jumbo Cover Plates: stainless steel.
- H. Weatherproof Cover Plates: Gasketed cast metal with hinged cover.

2.09 FLOOR BOX SERVICE FITTINGS

- A. Manufacturers:
 - 1. Hubbell Incorporated; : www.hubbell-wiring.com.
 - 2. Thomas & Betts Corporation; : www.tnb.com.
 - 3. Wiremold, a brand of Legrand North America, Inc; : www.legrand.us
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: Service fittings compatible with floor boxes provided under Section 26 05 37 with all components, adapters, and trims required for complete installation.
- C. Flush Floor Service Fittings:
 - 1. Dual Service Flush Combination Outlets:
 - a. Cover: Rectangular.
 - b. Configuration:
 - 1) Power: One standard convenience duplex receptacle(s) with duplex flap opening(s).
 - 2) Communications: Two Data Drops.
 - 3) Voice and Data Jacks: As specified in Section 27 10 05.
 - 2. Accessories:
 - a. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

2.10 POKE-THROUGH ASSEMBLIES

- A. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.
- B. Flush Floor Service Fittings:

1. Dual Service Flush Combination Outlets:
 - a. Cover: Hinged door(s).
 - b. Configuration:
 - 1) Power: One standard convenience duplex receptacle(s).
 - 2) Communications: Two data drops..
 - 3) Voice and Data Jacks: As specified in Section 27 10 05.
2. Accessories:
 - a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that openings in access floor are in proper locations.
- H. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1, including mounting heights specified in that standard unless otherwise indicated.
- C. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of wiring devices provided under this section.
 1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 2. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
- D. Install wiring devices in accordance with manufacturer's instructions.
- E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- G. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

- H. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- I. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.
- J. Unless otherwise indicated, GFCI receptacles may be connected to provide feed-through protection to downstream devices. Label such devices to indicate they are protected by upstream GFCI protection.
- K. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
- L. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- M. Install wall switches with OFF position down.
- N. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- O. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- P. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- Q. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- R. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.
- S. Install receptacles with grounding pole on top.
- T. Connect wiring device grounding terminal to outlet box with bonding jumper.
- U. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- V. Connect wiring devices by wrapping conductor around screw terminal.
- W. Use jumbo size plates for outlets installed in masonry walls.
- X. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.04 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 26 05 37 to obtain mounting heights.
- B. Install wall switch 48 inches above finished floor.
- C. Install convenience receptacle 18 inches above finished floor.
- D. Install convenience receptacle 6 inches above backsplash of counter.
- E. Install telephone jack 18 inches above finished floor.
- F. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches above finished floor.
- G. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 inches above finished floor.
- H. Coordinate installation of access floor boxes with access floor system provided under Section 09 6900.
- I. Coordinate the installation of wiring devices with underfloor duct service fittings provided under Section 26 0540.

3.05 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, adjusting, and balancing in accordance with Section 01 40 00.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Operate each wall switch with circuit energized and verify proper operation.
- E. Verify that each receptacle device is energized.
- F. Test each receptacle to verify operation and proper polarity.
- G. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- H. Correct wiring deficiencies and replace damaged or defective wiring devices.
- I. Verify that each telephone jack is properly connected and circuit is operational.

3.06 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.07 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 28 13
FUSES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Fuses.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- B. Section 26 05 73 - Overcurrent Protective Device Coordination Study: Additional criteria for the selection of protective devices specified in this section.
- C. Section 26 24 13 - Switchboards: Fusible switches.
- D. Section 26 24 16 - Panelboards: Fusible switches.
- E. Section 26 28 18 - Enclosed Switches: Fusible switches.
- F. Section 26 29 13 - Enclosed Controllers: Fusible switches.

1.03 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses.
- B. NFPA 70 - National Electrical Code.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses.
- E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - a. Fusible Switches for Enclosed Motor Controllers: See Section 26 29 13.
 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 2. Extra Fuses: One set(s) of three for each type and size installed.
 3. Fuse Pullers: One set(s) compatible with each type and size installed.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- E. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 MAINTENANCE MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.
- B. Furnish two fuse pullers.
- C. Furnish three of each size and type fuse installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Cooper Bussmann, a division of Cooper Industries: www.cooperindustries.com.
- B. Mersen (formerly Ferraz Shawmut): ferrazshawmut.mersen.com.
- C. Littelfuse, Inc: www.littelfuse.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 APPLICATIONS

- A. Service Entrance:
 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
- B. General Purpose Branch Circuits: Class RK1, time-delay.
- C. Primary Protection for Control Transformers: Class CC, time-delay.

2.03 FUSES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
- H. Class CC Fuses: Comply with UL 248-4.
- I. Power Load Feeder Switches: Class RK1 (time delay).
- J. Motor Load Feeder Switches: Class RK1 (time delay).
- K. Other Feeder Switches: Class RK1 (time delay).
- L. General Purpose Branch Circuits: Class RK1 (time delay).
- M. Motor Branch Circuits: Class L time delay.
- N. Lighting Branch Circuits: Class G.

2.04 CLASS RK1 (TIME DELAY) FUSES

- A. Manufacturers:
 - 1. Bussman Corp.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Construction: Current limiting, dual-element fuse, 10 seconds minimum at 500% rated amps, with copper fuse element.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

SECTION 26 28 17
ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Enclosed circuit breakers.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 05 73 - Overcurrent Protective Device Coordination Study: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- E. NFPA 70 - National Electrical Code.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- I. UL 869A - Reference Standard for Service Equipment.
- J. UL 943 - Ground-Fault Circuit-Interrupters.
- K. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.

- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 - 2. Include documentation of listed series ratings.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Maintain one copy of each document on site.
- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

1.09 EXTRA MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
- B. General Electric Company: www.geindustrial.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED CIRCUIT BREAKERS

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.

- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- D. Short Circuit Current Rating:
 - 1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location indicated on the drawings.
 - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.
- E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- F. Conductor Terminations: Suitable for use with the conductors to be installed.
- G. Provide thermal magnetic circuit breakers unless otherwise indicated.
- H. Provide electronic trip circuit breakers where indicated.
- I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- J. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
 - 3. Provide surface-mounted enclosures unless otherwise indicated.
- L. Provide externally operable handle with means for locking in the OFF position.
- M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
 - 1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
 - 2. Where accessory ground fault sensing and relaying equipment is used, equip companion circuit breakers with ground-fault shunt trips.
 - a. Use zero sequence ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

2.03 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity:
 - 1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - a. 14000 min. rms symmetrical amperes at 240 VAC or 208 VAC.
 - b. 21000 min. rms symmetrical amperes at 480 VAC.
 - 2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

3. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
- C. Conductor Terminations:
 1. Provide mechanical lugs unless otherwise indicated.
 2. Lug Material: Copper, suitable for terminating copper conductors only.
- D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 2. Provide interchangeable trip units for circuit breaker frame sizes 225 amperes and larger.
- E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 1. Provide the following field-adjustable trip response settings:
 - a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - b. Long time delay.
 - c. Short time pickup and delay.
 - d. Instantaneous pickup.
 - e. Ground fault pickup and delay where ground fault protection is indicated.
- F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
- G. Provide the following circuit breaker types where indicated:
 1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
- H. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
- I. Provide the following features and accessories where indicated or where required to complete installation:
 1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
- J. Molded Case Circuit Breakers: UL listed for the following service conditions:
 1. Temperature: 95 degrees F.
 2. Altitude: 1000 feet.

2.04 TRIP UNITS

- A. Field-Adjustable Trip Circuit Breakers: Provide circuit breakers with frame sizes 200 amperes and larger with mechanism for adjusting long time continuous current, short time pickup current setting for automatic operation. Range of Adjustment: amperes.
- B. Field-Changeable Ampere Rating Circuit Breaker: Provide circuit breakers with frame sizes 250 amperes and larger with changeable trip units.
- C. Current Limiting Circuit Breaker: Provide circuit breaker as indicated with automatically-resetting current limiting elements in each pole. Let-through Current and Energy: Less than permitted for same size Class RK-5 fuse.
- D. Solid-State Circuit Breaker: Provide circuit breaker as scheduled with electronic sensing, timing and tripping circuits for adjustable current settings; ground fault trip with zero sequence type ground fault sensor; instantaneous trip.

2.05 CURRENT LIMITERS

- A. Current Limiters: Designed for application with molded case circuit breaker.
- B. Coordinate limiter size with trip rating of circuit breaker to prevent nuisance tripping and to achieve interrupting current rating specified for circuit breaker.

- C. Provide interlocks to trip circuit breaker and to prevent closing circuit breaker when limiter compartment cover is removed or when one or more limiter is not in place or has operated.

2.06 ACCESSORIES

- A. Enclosures:
 - 1. Fabricate enclosures from steel.
 - 2. Finish: Manufacturer's standard enamel finish, gray color.
- B. Provide accessories as scheduled.
- C. Handle Lock: Include provisions for padlocking.
- D. Provide mechanical trip device.
- E. Provide grounding lug in each enclosure.
- F. Provide products suitable for use as service entrance equipment where so applied.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.
- B. Install enclosed circuit breakers securely, in a neat and workmanlike manner in accordance with NECA 1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 29.
- E. Install enclosed circuit breakers plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- I. Height: 5 feet to operating handle.
- J. Provide identification nameplates for each enclosed circuit breaker in accordance with Section 26 0553.
- K. Provide arc flash warning labels in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect and test in accordance with manufacturer's instructions and NETA STD ATS, except Section 4.

- C. Perform inspections and tests listed in NETA STD ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than 400 amperes. Tests listed as optional are not required.
- D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- E. Test GFCI circuit breakers to verify proper operation.
- F. Test shunt trips to verify proper operation.
- G. Correct deficiencies and replace damaged or defective enclosed circuit breakers.
- H. Perform field inspection and testing in accordance with Section 01 4000.
- I. Inspect and test each circuit breaker.
- J. Inspect each circuit breaker visually.
- K. Perform several mechanical ON-OFF operations on each circuit breaker.
- L. Verify circuit continuity on each pole in closed position.
- M. Determine that circuit breaker will trip on overcurrent condition, with tripping time to NEMA AB 1 requirements.
- N. Include description of testing and results in test report.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 28 18
ENCLOSED SWITCHES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Enclosed safety switches.
- B. Fusible switches.
- C. Nonfusible switches.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 05 73 - Overcurrent Protective Device Coordination Study: Additional criteria for the selection of equipment and associated protective devices specified in this section.
- E. Section 26 28 13 - Fuses.
- F. Section 26 29 13 - Enclosed Controllers: Manual motor controllers.
- G. Section 26 36 00 - Transfer Switches: Automatic and non-automatic switches listed for use as transfer switch equipment.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association.
- D. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- E. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- F. NFPA 70 - National Electrical Code.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- I. UL 98 - Enclosed and Dead-Front Switches.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- C. Project Record Documents: Record actual locations of enclosed switches.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Eaton Corporation; Cutler-Hammer Products; Model : www.eaton.com.
- B. General Electric Company; Model : www.geindustrial.com.
- C. Schneider Electric; Square D Products; Model : www.schneider-electric.us.

- D. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
- I. Conductor Terminations: Suitable for use with the conductors to be installed.
- J. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
- L. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- M. Heavy Duty Switches:
 - 1. Products:
 - a. Schneider Electric.
 - b. General Electric Co.
 - c. Cutler Hammer.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Comply with NEMA KS 1.
 - 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Provide compression lugs where indicated.
 - c. Lug Material: Copper, suitable for terminating copper conductors only.
 - 4. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

2.03 COMPONENTS

- A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
 - 1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 - 2. Handle lockable in OFF position.
 - 3. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.

- B. Nonfusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
 - 1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 - 2. Handle lockable in OFF position.
- C. Enclosures: NEMA KS 1.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install enclosed switches in accordance with manufacturer's instructions.
- B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 29.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Provide identification nameplate for each enclosed switch in accordance with Section 26 0553.
- J. Provide arc flash warning labels in accordance with NFPA 70.
- K. Install fuses in fusible disconnect switches.
- L. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.5.1.1.
- D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 2 PRODUCTS

1.01 ENCLOSED MOTOR CONTROLLERS

- A. Provide enclosed motor controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Description: Enclosed motor controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.
- D. Service Conditions:
 - 1. Provide motor controllers and associated components suitable for operation under the following service conditions without derating:
 - a. Altitude:
 - 1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet.
 - 2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.
 - b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
 - 2. Provide motor controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
- E. Short Circuit Current Rating:
- F. Conductor Terminations: Suitable for use with the conductors to be installed.
- G. Enclosures:
 - 1. Comply with NEMA ICS 6.
 - 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 3. Finish: Manufacturer's standard unless otherwise indicated.
- H. Instrument Transformers:
 - 1. Comply with IEEE C57.13.
 - 2. Select suitable ratio, burden, and accuracy as required for connected devices.
 - 3. Current Transformers: Connect secondaries to shorting terminal blocks.
 - 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

1.02 OVERCURRENT PROTECTIVE DEVICES

- A. Overload Relays:
 - 1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
 - 2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
 - 3. Trip-free operation.
 - 4. Visible trip indication.
 - 5. Resettable.
 - a. Employ manual reset unless otherwise indicated.
 - b. Do not employ automatic reset with two-wire control.

END OF SECTION

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SECTION 26 29 23
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Variable frequency controllers.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Housekeeping pads.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 28 13 - Fuses.

1.03 REFERENCE STANDARDS

- A. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems.
- B. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- E. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- D. Test Reports: Indicate field test and inspection procedures and test results.
- E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Manufacturer's Field Reports: Indicate start-up inspection findings.
- G. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
- H. Maintenance Data: NEMA ICS 7.1. Include routine preventive maintenance schedule.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. ABB: www.ABB.com.
- B. Schneider Electric; Square D Products: www.schneider-electric.us.
- C. Danfoss: www.danfoss.us.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DESCRIPTION

- A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.
 - 1. Employ pulse-width-modulated inverter system.
 - 2. Design for ability to operate controller with motor disconnected from output.
 - 3. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.
- B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places regularly open to the public.
- C. Finish: Manufacturer's standard enamel.

2.03 OPERATING REQUIREMENTS

- A. Rated Input Voltage: 480 volts, three phase, 60 Hertz.
- B. Motor Nameplate Voltage: 460 volts, three phase, 60 Hertz.
- C. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
- D. Operating Ambient: 0 degrees C to 40 degrees C.
- E. Minimum Efficiency at Full Load: 85 percent.
- F. Time to Stop: 5 seconds.
- G. Volts Per Hertz Adjustment: Plus or minus 0 percent.
- H. Current Limit Adjustment: 60 to 110 percent of rated.
- I. Acceleration Rate Adjustment: 0.5 to 30 seconds.
- J. Deceleration Rate Adjustment: 1 to 30 seconds.
- K. Input Signal: 4 to 20 mA DC.

2.04 COMPONENTS

- A. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.
- B. Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.
- C. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control.
- D. Include undervoltage release.

- E. Control Power Source: Integral control transformer.
- F. Door Interlocks: Furnish mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.
- G. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.
- H. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.
- I. Manual Bypass: Furnish contactor, motor running overload protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch to allow maintenance of inverter during bypass operation.
- J. Emergency Stop: Use dynamic brakes for emergency stop function.
- K. Disconnecting Means: Include integral fused disconnect switch on the line side of each controller.
- L. Wiring Terminations: Match conductor materials and sizes indicated.
- M. Line Reactor: Furnish line reactor (s) for harmonics mitigation.

2.05 SOURCE QUALITY CONTROL

- A. Shop inspect and perform standard production tests for each controller.
- B. Make completed controller available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least 7 days before inspection is allowed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surface is suitable for controller installation.
- B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.
- C. Verify that field measurements are as indicated on shop drawings.

3.02 INSTALLATION

- A. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.
- B. Tighten accessible connections and mechanical fasteners after placing controller.
- C. Provide fuses in fusible switches; refer to Section 26 28 13 for product requirements.
- D. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- E. Identify variable frequency controllers in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. Provide the service of the manufacturer's field representative to prepare and start controllers.
- B. Perform field inspection and testing in accordance with Section 01 40 00.
- C. Inspect and test in accordance with NETA STD ATS, except Section 4.
- D. Perform inspections and tests listed in NETA STD ATS, Section 7.17.

3.04 ADJUSTING

- A. Make final adjustments to installed controller to assure proper operation of load system. Obtain performance requirements from installer of driven loads.

3.05 CLOSEOUT ACTIVITIES

- A. Demonstrate operation of controllers in automatic and manual modes.

3.06 MAINTENANCE

- A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Provide service and maintenance of controllers for one year from Date of Substantial Completion.

END OF SECTION

SECTION 26 32 13
ENGINE GENERATORS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Packaged engine generator system and associated components and accessories:
 - 1. Engine and engine accessory equipment.
 - 2. Alternator (generator).
 - 3. Generator set control system.
 - 4. Generator set enclosure.
- B. Packaged engine generator set.
- C. Heat exchanger.
- D. Exhaust silencer, emissions controls, and fittings.
- E. Remote control panel.
- F. Battery and charger.
- G. Sound enclosure.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 22 10 05 - Plumbing Piping: Gas piping.
- C. Section 23 11 23 - Facility Natural-Gas Piping.
- D. Section 23 31 00 - HVAC Ducts and Casings.
- E. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- F. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- H. Section 26 36 00 - Transfer Switches.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA/EGSA 404 - Standard for Installing Generator Sets.
- C. NEMA MG 1 - Motors and Generators.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.
- E. NFPA 30 - Flammable and Combustible Liquids Code.
- F. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
- G. NFPA 70 - National Electrical Code.
- H. NFPA 99 - Health Care Facilities Code.
- I. NFPA 110 - Standard for Emergency and Standby Power Systems.
- J. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries.
- K. UL 2200 - Stationary Engine Generator Assemblies.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
 - a. Transfer Switches: See Section 26 36 00.
2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
 1. Include generator set sound level test data.
 2. Include characteristic trip curves for overcurrent protective devices upon request.
 3. Include alternator thermal damage curve upon request.
- C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
- D. Specimen Warranty: Submit sample of manufacturer's warranty.
- E. Evidence of qualifications for installer.
- F. Evidence of qualifications for maintenance contractor (if different entity from installer).
- G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- H. Manufacturer's factory emissions certification.
- I. Manufacturer's certification that products meet or exceed specified requirements.
- J. Source quality control test reports.
- K. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
 1. Certified prototype tests.
 2. Torsional vibration compatibility certification.
 3. NFPA 110 compliance certification.
 4. Certified rated load test at rated power factor.
- L. Manufacturer's detailed field testing procedures.
- M. Field quality control test reports.
- N. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

- O. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- P. Maintenance contracts.
- Q. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.
- R. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Fuses: One of each type and size.
 - 3. Extra Filter Elements: One of each type, including fuel, oil and air.
- S. Shop Drawings: Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.
- T. Product Data: Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, and remote radiator.
- U. Test Reports: Indicate results of performance testing.
- V. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- W. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- X. Manufacturer's Field Reports: Indicate procedures and findings.
- Y. Operation Data: Include instructions for normal operation.
- Z. Maintenance Data: Include instructions for routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.
- AA. Maintenance Materials and Tools: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Filter Elements: One of each type, including fuel, oil and air.
 - 2. Tools: One set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal tool box.

1.06 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70 (National Electrical Code).
 - 2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.
 - 3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
 - 1. Authorized service facilities located within 200 miles of project site.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.

- E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
 - 1. Contract maintenance office located within 200 miles of project site.
- F. Products: Listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authorities having jurisdiction as suitable for the purpose indicated.
- G. Conform to requirements of NFPA 70.
 - 1. Maintain one copy of each document on site.
- H. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.
- I. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- J. Products: Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
- C. Accept unit on site on skids. Inspect for damage.
- D. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Packaged Engine Generator Set - Basis of Design: Kohler Power Systems; Model 50 REZGB
- B. Packaged Engine Generator Set - Other Acceptable Manufacturers:
 - 1. Caterpillar Inc: www.cat.com/power-generation.
 - 2. Cummins Power Generation Inc: www.cumminspower.com.
 - 3. Generac Power Systems: www.generac.com/industrial.
- C. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- E. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

- F. Caterpillar Inc: www.caterpillar.com.
- G. Cummins Engine Company, I: www.cummins.com.
- H. Kohler Power Systems: www.kohler.com.
- I. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PACKAGED ENGINE GENERATOR SYSTEM

- A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. System Description:
 - 1. Application: _Stand by.
 - 2. Configuration: Single packaged engine generator set operated independently (not in parallel).
- D. Packaged Engine Generator Set:
 - 1. Type: Gaseous (spark ignition).
 - 2. Basis of Design: Kohler Power Systems Model 50 REZGB.
 - 3. Power Rating: As indicated on drawings, standby.
 - 4. Voltage: As indicated on drawings.
 - 5. Main Line Circuit Breaker:
 - a. Type: Thermal magnetic.
 - b. Trip Rating: Select according to generator set rating.
 - c. Features:
- E. Generator Set General Requirements:
 - 1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
 - 2. Factory-assembled, with components mounted on suitable base.
 - 3. List and label engine generator assembly as complying with UL 2200.
 - 4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
 - 5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
 - 6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.
- F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.
 - 1. Altitude: 1000 feet.
 - 2. Ambient Temperature: Between 0 and 104 degrees F.
- G. Starting and Load Acceptance Requirements:
 - 1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
 - 2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
 - 3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
 - 4. Maximum Load Step: Supports 100 percent of rated load in one step.
- H. Exhaust Emissions Requirements:

1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

I. Sound Level Requirements:

1. Do not exceed 69 dBA when measured at 23 feet from generator set in free field (no sound barriers) while operating at full load; include manufacturer's sound data with submittals.

J. Description: NFPA 110, engine generator system to provide source of power for Level 1 applications conforming to NFPA 99.

K. System Capacity: 50 kW, 63 kVA at elevation of 100 feet above sea level, continuous rating using engine-mounted radiator.

2.03 ENGINE AND ENGINE ACCESSORY EQUIPMENT

- A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.
- B. Engine Fuel System - Gaseous (Spark Ignition):
 1. Fuel Source: Natural gas.
 2. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
 3. Provide components/features indicated and as necessary for operation and/or required by applicable codes, including but not limited to:
 - a. Carburetor.
 - b. Gas pressure regulators.
 - c. Fuel shutoff control valves.
 - d. Low gas pressure switches.
- C. Engine Starting System:
 1. System Type: Electric, with DC solenoid-activated starting motor(s).
 2. Battery(s):
 - a. Battery Type: Lead-acid.
 - b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
 - c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
 3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
 4. Battery Charger:
 - a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
 - b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
 - c. Recognized as complying with UL 1236.
 - d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
 - e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
 - f. Provide alarm output contacts as necessary for alarm indications.

5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.
- D. Engine Speed Control System (Governor):
 1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
 2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.
- E. Engine Lubrication System:
 1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
 2. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.
- F. Engine Cooling System:
 1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
 2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
- G. Engine Air Intake and Exhaust System:
 1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
 2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
 3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.
- H. Type: Water-cooled inline or V-type, four stroke cycle, electric ignition natural-gas internal combustion engine.
- I. Rating: Sufficient to operate under 10 percent overload for one hour in an ambient of 90 degrees F at elevation of 1000 feet.
- J. Fuel System: Natural gas. Include manufacturer's approved regulator for pressure reduction from supply pressure.
- K. Engine speed: 1800 rpm.
- L. Governor: Isochronous type to maintain engine speed within 0.5 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes. Equip governor with means for manual operation and adjustment.
- M. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.
- N. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.
- O. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 120 volts AC.
- P. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F. Radiator air flow restriction 0.5 inches of water maximum.

- Q. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gage, water temperature gage, and lube oil pressure gage on engine/generator control panel.
- R. Mounting: Provide unit with suitable spring-type vibration isolators and mount on structural steel base.

2.04 ALTERNATOR (GENERATOR)

- A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.
- B. Exciter:
 1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
 2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
 3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.
- C. Temperature Rise: Comply with UL 2200.
- D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.
- E. Enclosure: NEMA MG 1, drip-proof.
- F. Total Harmonic Distortion: Not greater than five percent.
- G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

2.05 GENERATOR SET CONTROL SYSTEM

- A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.
- B. Control Panel:
 1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
 2. Generator Set Control Functions:
 - a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
 - b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
 - c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
 - d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
 - e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
 - f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
 - g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
 3. Generator Set Status Indications:
 - a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
 - b. Current (Amps): For each phase.
 - c. Frequency (Hz).
 - d. Real power (W/kW).
 - e. Reactive power (VAR/kVAR).
 - f. Apparent power (VA/kVA).
 - g. Power factor.
 - h. Duty Level: Actual load as percentage of rated power.
 - i. Engine speed (RPM).

- j. Battery voltage (Volts DC).
- k. Engine oil pressure.
- l. Engine coolant temperature.
- m. Engine run time.
- n. Generator powering load (position signal from transfer switch).
- 4. Generator Set Protection and Warning/Shutdown Indications:
 - a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
 - 1) Overcrank (shutdown).
 - 2) Low coolant temperature (warning).
 - 3) High coolant temperature (warning).
 - 4) High coolant temperature (shutdown).
 - 5) Low oil pressure (shutdown).
 - 6) Overspeed (shutdown).
 - 7) Low fuel level (warning).
 - 8) Low coolant level (warning/shutdown).
 - 9) Generator control not in automatic mode (warning).
 - 10) High battery voltage (warning).
 - 11) Low cranking voltage (warning).
 - 12) Low battery voltage (warning).
 - 13) Battery charger failure (warning).
 - b. In addition to NFPA 110 requirements, provide the following protections/indications:
 - 1) High AC voltage (shutdown).
 - 2) Low AC voltage (shutdown).
 - 3) High frequency (shutdown).
 - 4) Low frequency (shutdown).
 - 5) Overcurrent (shutdown).
 - c. Provide contacts for local and remote common alarm.
 - d. Provide lamp test function that illuminates all indicator lamps.
- 5. Other Control Panel Features:
 - a. Event log.
 - b. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
 - c. Remote monitoring capability via PC.

C. Remote Annunciator:

- 1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
- 2. Generator Set Status Indications:
 - a. Generator powering load (via position signal from transfer switch).
 - b. Communication functional.
- 3. Generator Set Warning/Shutdown Indications:
 - a. Comply with NFPA 110 for Level 1 systems including but not limited to the following indications:
 - 1) Overcrank (shutdown).
 - 2) Low coolant temperature (warning).
 - 3) High coolant temperature (warning).
 - 4) High coolant temperature (shutdown).
 - 5) Low oil pressure (shutdown).
 - 6) Overspeed (shutdown).
 - 7) Low fuel level (warning).

- 8) Low coolant level (warning/shutdown).
- 9) Generator control not in automatic mode (warning).
- 10) High battery voltage (warning).
- 11) Low cranking voltage (warning).
- 12) Low battery voltage (warning).
- 13) Battery charger failure (warning).

- b. Provide audible alarm with silence function.
- c. Provide lamp test function that illuminates all indicator lamps.

D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

2.06 GENERATOR SET ENCLOSURE

- A. Enclosure Type: Sound attenuating, weather protective.
- B. Enclosure Material: Steel.
- C. Hardware Material: Stainless steel.
- D. Color: Manufacturer's standard.
- E. Access Doors: Lockable, with all locks keyed alike.
- F. Openings: Designed to prevent bird/rodent entry.
- G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.
- H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.
- I. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.
- J. Enclosure Space Heater: Provide thermostatically controlled enclosure space heater to prevent condensation and improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

2.07 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.
- C. Generator Set production testing to include, at a minimum:
 1. Operation at rated load and rated power factor.
 2. Single step load pick-up.
 3. Transient and steady state voltage and frequency performance.
 4. Operation of safety shutdowns.
- D. Generator: NEMA MG 1, three phase, four pole, reconnectable brushless synchronous generator with brushless exciter.
- E. Rating: 50 kW, 63 kVA, at 0.8 power factor, 480Y-277 volts, 60 Hz at 1800 rpm.
- F. Insulation Class: F.
- G. Temperature Rise: 130 degrees C Standby.
- H. Enclosure: NEMA MG 1, open drip proof.
- I. Voltage Regulation: Include generator-mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no

load to full load. Include manual controls to adjust voltage droop, voltage level (plus or minus 5 percent) and voltage gain.

2.08 ACCESSORIES

- A. Heat Exchanger: Engine or base-mounted heat exchanger and expansion tank of type and capacity recommended by engine manufacturer. Include solenoid shut-off valve for installation on the cooling water inlet, and connected to open when engine runs.
- B. Exhaust Silencer: Residential type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, sized in accordance with engine manufacturer's instructions.
- C. Batteries: Heavy duty, diesel starting type lead-acid storage batteries, 170 ampere-hours minimum capacity. Match battery voltage to starting system. Include necessary cables and clamps.
- D. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.
- E. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet NEMA 250, Type 1 requirements.
- F. Line Circuit Breaker: Molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole, sized in accordance with NFPA 70; UL listed. Include battery-voltage operated shunt trip, connected to open circuit breaker on engine failure. Unit mount in enclosure to meet NEMA 250, Type 1 requirements.
- G. Engine-Generator Control Panel: NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:
 - 1. Frequency Meter: 45-65 Hz. range, 3.5 inch dial.
 - 2. AC Output Voltmeter: 3.5 inch dial, 2 percent accuracy, with phase selector switch.
 - 3. AC Output Ammeter: 3.5 inch dial, 2 percent accuracy, with phase selector switch.
 - 4. Output voltage adjustment.
 - 5. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, overspeed, and overcrank.
 - 6. Engine start/stop selector switch.
 - 7. Engine running time meter.
 - 8. Oil pressure gage.
 - 9. Water temperature gage.
 - 10. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
 - 11. Additional visual indicators and alarms as required by NFPA 110.
 - 12. Remote Alarm Contacts: Pre-wire SPDT contacts to terminal strip for remote alarm functions required by NFPA 110.
- H. Remote Annunciator Panel: Surface mounted panel with brushed stainless steel. Provide audible and visible indicators and alarms required by NFPA 110.
- I. Emissions controls: Catalyst based, meeting State of Delaware Department of Natural Resources and Environmental Controls standards for stand-by generators.
- J. Sound Enclosure: Lift based steel construction with hinged doors, Acoustic insulation meeting UL94HF1 flammability classification and repels moisture absorption. Maximum sound level shall be 69 dB at 23.1 ft.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.

- B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.
- C. Verify that rough-ins for field connections are in the proper locations.
- D. Verify that mounting surfaces are ready to receive equipment.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install products in accordance with manufacturer's instructions.
- C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.
- D. Arrange equipment to provide minimum clearances and required maintenance access.
- E. Unless otherwise indicated, mount generator set on properly sized 6 inch high concrete pad constructed in accordance with Section 03 30 00. Provide suitable vibration isolators, where not factory installed.
- F. Provide required support and attachment in accordance with Section 26 05 29.
- G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.
- H. Provide natural gas piping in accordance with Section 23 11 23.
- I. Provide gas piping in accordance with Section 22 10 05.
- J. Provide engine exhaust piping in accordance with Section 23 51 00, where not factory installed.
 - 1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
 - 2. Do not exceed manufacturer's maximum back pressure requirements.
- K. Install exhaust silencer in accordance with Section 23 51 00, where not factory installed.
- L. Provide grounding and bonding in accordance with Section 26 05 26.
- M. Identify system wiring and components in accordance with Section 26 05 53.
- N. All incoming feeders shall enter from bottom of portable generator connection box and conduits shall exit from sides only.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- C. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.
- D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.
- F. Preliminary inspection and testing to include, at a minimum:
 - 1. Inspect each system component for damage and defects.
 - 2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
 - 3. Check for proper oil and coolant levels.
- G. Prepare and start system in accordance with manufacturer's instructions.

- H. Perform acceptance test in accordance with NFPA 110.
- I. Inspection and testing to include, at a minimum:
 - 1. Verify compliance with starting and load acceptance requirements.
 - 2. Verify voltage and frequency; make required adjustments as necessary.
 - 3. Verify phase sequence.
 - 4. Verify control system operation, including safety shutdowns.
 - 5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
- J. Provide field emissions testing where necessary for certification.
- K. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- L. Submit detailed reports indicating inspection and testing results and corrective actions taken.
- M. Provide the services of manufacturer's representative to prepare and start system.
- N. Perform field inspection and testing in accordance with Section 01 4000.
- O. Provide full load test utilizing portable test bank, if required, for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal.
- P. Record in 20 minute intervals during four hour test:
 - 1. Kilowatts.
 - 2. Amperes.
 - 3. Voltage.
 - 4. Coolant temperature.
 - 5. Room temperature.
 - 6. Frequency.
 - 7. Oil pressure.
- Q. Test alarm and shutdown circuits by simulating conditions.
- R. Field-verify emissions levels to meet manufacturer's documented criteria per submittals.

3.04 ADJUSTING

- A. Adjust generator output voltage and engine speed.

3.05 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
- C. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of four hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.

3.07 PROTECTION

- A. Protect installed engine generator system from subsequent construction operations.
- B. Demonstrate operation to Owner's operating personnel:

1. Describe loads connected to emergency system and restrictions for future load additions.
2. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency power.

3.08 MAINTENANCE

- A. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.
- B. Provide trouble call-back service upon notification by Owner:
 1. Provide on-site response within 4 hours of notification.
 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- C. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.
- D. Provide a separate maintenance contract for specified maintenance service.
- E. Provide service and maintenance of engine generator for one year from Date of Substantial Completion.

END OF SECTION

SECTION 26 36 00
TRANSFER SWITCHES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
 - 1. Automatic transfer switches.
 - 2. Remote annunciators.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 05 73 - Overcurrent Protective Device Coordination Study: Additional criteria for the selection of equipment specified in this section.
- F. Section 26 28 18 - Enclosed Switches: Safety switches not listed for use as transfer switch equipment.
- G. Section 26 32 13 - Engine Generators: For interface with transfer switches.
 - 1. Includes code requirements applicable to work of this section.
 - 2. Includes additional testing requirements.
- H. Section - Engine Generators: Testing requirements.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- E. NFPA 70 - National Electrical Code.
- F. NFPA 110 - Standard for Emergency and Standby Power Systems.
- G. UL 1008 - Transfer Switch Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
 - 2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
 - 3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
 - 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

- C. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
 - 1. Where applicable, include characteristic trip curves for overcurrent protective devices upon request.
- C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- E. Manufacturer's certification that products meet or exceed specified requirements.
- F. Source quality control test reports.
- G. Manufacturer's detailed field testing procedures.
- H. Field quality control test reports.
- I. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 - 1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.
- J. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- K. Maintenance contracts.
- L. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.
- M. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
- N. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.
- O. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- P. Operation Data: Instructions for operating equipment under emergency conditions when engine generator is running.
- Q. Maintenance Data: Routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.06 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70 (National Electrical Code).
 - 2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for system Level specified in Section 26 32 13.

- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
 - 1. Authorized service facilities located within 200 miles of project site.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with power transfer systems of similar size, type, and complexity; manufacturer's authorized installer.
- E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- G. Conform to requirements of NFPA 70.
- H. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- I. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- J. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Transfer Switches - Basis of Design: ASCO power technologies 300 series..
- B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
- C. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

E. Source Limitations: Furnish transfer switches and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 TRANSFER SWITCHES

- A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Applications:
 - 1. Utilize open transition transfer unless otherwise indicated or required.
- D. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.
- E. Automatic Transfer Switch:
 - 1. Basis of Design: ASCO transfer switches 300 series, .
- F. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).
- G. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.
- H. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.
- I. Switching Methods:
 - 1. Open Transition:
 - a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
 - 2. Obtain control power for transfer operation from line side of source to which the load is to be transferred.
- J. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.
 - 1. Altitude: 1000 feet.
 - 2. Ambient Temperature: Between 0 degrees F and 104 degrees F.
- K. Enclosures:
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 12.
 - b. Outdoor Locations: Type 3R or Type 4.
 - 2. Provide lockable door(s) for outdoor locations.
 - 3. Finish: Manufacturer's standard unless otherwise indicated.
- L. Short Circuit Current Rating:
- M. Automatic Transfer Switches:
 - 1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
 - 2. Control Functions:
 - a. Automatic mode.
 - b. Test Mode: Simulates failure of primary/normal source.
 - c. Voltage and Frequency Sensing:

- 1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
- 2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
- 3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
- d. Outputs:
 - 1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).
 - 2) Auxiliary contacts; one set(s) for each switch position.
- e. Adjustable Time Delays:
 - 1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
 - 2) Transfer to alternate/emergency source time delay.
 - 3) Retransfer to primary/normal source time delay.
 - 4) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.
- f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.
- g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.

3. Status Indications:
 - a. Connected to alternate/emergency source.
 - b. Connected to primary/normal source.
 - c. Alternate/emergency source available.
 - d. Primary/normal source available.
4. Other Features:
 - a. Event log.
 - b. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
5. Automatic Sequence of Operations:
 - a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
 - b. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
 - c. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
 - d. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

N. Remote Annunciators:

1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
2. Transfer Switch Status Indications:
 - a. Connected to alternate/emergency source.
 - b. Connected to primary/normal source.
 - c. Alternate/emergency source available.
 - d. Primary/normal source available.

- O. Interface with Other Work:
 - 1. Interface with engine generators as specified in Section 26 32 13.
 - 2.

2.03 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

2.04 AUTOMATIC TRANSFER SWITCH

- A. Description: NEMA ICS 10, automatic transfer switch 400 amp,3 pole, in NEMA1 enclosure.
- B. Configuration: Electrically operated, mechanically held transfer switch.
- C. Interrupting Capacity: 42000 amp minimum ,rms .

2.05 SERVICE CONDITIONS

- A. Service Conditions: NEMA ICS 10.
- B. Temperature: 105 deg F.
- C. Altitude: 3,300 feet.

2.06 COMPONENTS

- A. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE.
- B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
- C. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate source to normal source.
- D. Transfer Switch Auxiliary Contacts: 1 normally open; 1 normally closed.
- E. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 percent from rated nominal value.
- F. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal value.
- G. In-Phase Monitor: Inhibit transfer until source and load are within zero electrical degrees.
- H. Switched Neutral: Overlapping contacts.
- I. Enclosure: ICS 10, Type 1, finished with manufacturer's standard gray enamel.

2.07 AUTOMATIC SEQUENCE OF OPERATION

- A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
- B. Time Delay To Start Alternate Source Engine Generator: 0 to 6 seconds, adjustable.
- C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
- D. Time Delay Before Transfer to Alternate Power Source: 0 to 60 seconds, adjustable.
- E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
- F. Time Delay Before Transfer to Normal Power: 0 to 60 seconds, adjustable; bypass time delay in event of alternate source failure.
- G. Time Delay Before Engine Shut Down: 0 to 1 minutes, adjustable, of unloaded operation.
- H. Engine Exerciser: Start engine every 15days run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.
- C. Verify that rough-ins for field connections are in the proper locations.
- D. Verify that surface is suitable for transfer switch installation.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide 6" housekeeping pads.

3.03 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install in accordance with manufacturer's instructions.
- C. Arrange equipment to provide minimum clearances and required maintenance access.
- D. Install transfer switches plumb and level.
- E. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.
- F. Provide grounding and bonding in accordance with Section 26 05 26.
- G. Identify transfer switches in accordance with Section 26 05 53.
- H. Provide engraved plastic nameplates under the provisions of Section 26 0553.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- C. Prepare and start system in accordance with manufacturer's instructions.
- D. Automatic Transfer Switches:
 - 1. Inspect and test in accordance with NETA ATS, except Section 4.
 - 2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The control wiring insulation-resistance tests listed as optional are not required.
 - a. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- E. Provide additional inspection and testing as required for completion of associated engine generator testing as specified in Section 26 32 13.
- F. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- G. Submit detailed reports indicating inspection and testing results and corrective actions taken.
- H. Provide the services of the manufacturer's technical representative to check out transfer switch connections and operation and place in service.
- I. Perform field inspection and testing in accordance with Section .
- J. Inspect and test in accordance with NETA STD ATS, except Section 4.

- K. Perform inspections and tests listed in NETA STD ATS, Section 7.22.3.

3.05 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.
- D. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of four hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.
- E. Demonstrate operation of transfer switch in bypass, normal, and emergency modes.

3.07 PROTECTION

- A. Protect installed transfer switches from subsequent construction operations.

3.08 MAINTENANCE

- A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of transfer switches for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.
- C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
- D. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 4 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- E. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.
- F. Provide a separate maintenance contract for specified maintenance service.
- G. Provide service and maintenance of transfer switches for one year from Date of Substantial Completion.

END OF SECTION

SECTION 26 43 00
SURGE PROTECTIVE DEVICES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Surge protective devices for service entrance locations.
- B. Surge protective devices for distribution locations.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding.
- B. Section - Wiring Devices: Receptacles with integral surge protection.
- C. Section 26 24 13 - Switchboards.
- D. Section 26 24 16 - Panelboards.
- E. Section 27 10 05 - Structured Cabling for Voice and Data: Protectors for communications service entrance.

1.03 ABBREVIATIONS AND ACRONYMS

- A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
- B. SPD: Surge Protective Device.

1.04 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- D. NFPA 70 - National Electrical Code.
- E. UL 1449 - Standard for Surge Protective Devices.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
 - 1. SPDs with EMI/RFI filter: Include noise attenuation performance.
- C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.
- D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
 - 1. UL 1449.
 - 2. UL 1283 (for Type 2 SPDs).

- E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.
- G. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- H. Project Record Documents: Record actual connections and locations of surge protective devices.

1.07 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.08 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.09 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: Schneider Electric; Square D Brand Surgelogic Products as indicated under product article(s) below; www.surgelogic.com.
- B. Surge Protective Devices (SPD) as manufactured by Siemens Industry, Inc. are a permitted substitution with the inclusion of a Surge Counter and an External Operable Disconnect.
- C. Surge Protective Devices (SPD) as manufactured by Advanced Protection Technologies, Inc. are a permitted substitution with inclusion of an externally operable switch / breaker.
- D. Factory-installed, Internally Mounted Surge Protective Devices:
 1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.
- E. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.02 ALL SURGE PROTECTIVE DEVICES

- A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service, listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated; system voltage as indicated on the drawings.
- B. Protected Modes:
 1. Wye Systems: L-N, L-G, N-G, L-L.

- C. UL 1449 Voltage Protection Ratings (VPRs):
 - 1. Equivalent to basis of design.
 - 2. 480Y/277V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.
- D. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
- E. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 1. Indoor clean, dry locations: Type 1.
- F. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
- G. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
 - 1. Switchboards: See Section 26 24 13.

2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

- A. Unless otherwise indicated, provide field-installed, externally mounted or factory-installed, internally mounted SPDs.
- B. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.
- D. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
- E. Repetitive Surge Current Capacity: Not less than 5,000 impulses.
- F. UL 1449 Nominal Discharge Current (I-n): 20 kA.
- G. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
- H. Diagnostics:
 - 1. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
 - 2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
- I. Basis of Design: Schneider Electric; Square D Brand Surgelogic Products; www.surgelogic.com.
 - 1. Field-installed, Externally Mounted Surge Protective Devices:
 - a. EMA Series: Replaceable modules; 200 kA SCCR; individually fused MOVs, thermal fusing; dry contacts; EMI/RFI filtering; surge counter; duty cycle tested for 20,000 impulses; 10 year warranty.
 - 2. Factory-installed, Internally Mounted Surge Protective Devices:
 - a. IMA Series: Replaceable modules; 200 kA SCCR; individually fused MOVs, thermal fusing; dry contacts; EMI/RFI filtering; surge counter; duty cycle tested for 20,000 impulses; 10 year warranty.

2.04 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

- A. Unless otherwise indicated, provide field-installed, externally mounted or factory-installed, internally mounted SPDs.
- B. List and label as complying with UL 1449, Type 1 or Type 2.
- C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

- D. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.
- E. UL 1449 Nominal Discharge Current (I-n): 20 kA.
- F. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
- G. Diagnostics:
 - 1. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
 - 2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
- H. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.
- I. Basis of Design: Schneider Electric; Square D Brand Surgelogic Products; www.surgelogic.com.
 - 1. Field-installed, Externally Mounted Surge Protective Devices:
 - a. EMA Series: Replaceable modules; 200 kA SCCR; individually fused MOVs, thermal fusing; dry contacts; EMI/RFI filtering; surge counter; duty cycle tested for 20,000 impulses; 10 year warranty.
 - 1) Furnished with integral switch option where indicated.
 - 2. Factory-installed, Internally Mounted Surge Protective Devices:
 - a. IMA Series: Replaceable modules; 200 kA SCCR; individually fused MOVs, thermal fusing; dry contacts; EMI/RFI filtering; surge counter; duty cycle tested for 20,000 impulses; 10 year warranty.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
- C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of the drawings and manufacturer's instructions.
- D. Verify system grounding and bonding is in accordance with Section 26 05 26, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install SPD in accordance with manufacturer's instructions.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.
- E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably be rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.

- F. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

3.03 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS Section 7.19.1.
- D. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

3.04 CLEANING

- A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Interior luminaires.
- B. Emergency lighting units.
- C. Exit signs.
- D. Ballasts.
- E. Lamps.
- F. Luminaire accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 37 - Boxes.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 09 23 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
- D. Section 26 27 26 - Wiring Devices: Manual wall switches and wall dimmers.
- E. Section 26 56 00 - Exterior Lighting.

1.03 REFERENCE STANDARDS

- A. ANSI C78.379 - American National Standard for Electric Lamps -- Reflector Lamps -- Classification of Beam Patterns.
- B. ANSI C82.1 - American National Standard for Lamp Ballast - Line Frequency Fluorescent Lamp Ballast.
- C. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).
- D. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements.
- E. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
- F. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society.
- G. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules.
- H. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- I. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems.
- J. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems.
- K. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association.
- L. NFPA 70 - National Electrical Code.
- M. NFPA 101 - Life Safety Code.
- N. UL 924 - Emergency Lighting and Power Equipment.

- O. UL 935 - Fluorescent-Lamp Ballasts.
- P. UL 1598 - Luminaires.
- Q. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
 - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
 - 3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
 - 4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 - 2. Provide photometric calculations where luminaires are proposed for substitution upon request.
- C. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- D. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - b. Include IES LM-79 test report upon request.
- E. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.
- F. Field Quality Control Reports.
- G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- H. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.
 - 3. Extra Lamps: Ten percent of total quantity installed for each type, but not less than two of each type.

4. Extra Ballasts: Two percent of total quantity installed for each type, but not less than one of each type.
- J. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Conform to requirements of NFPA 70 and NFPA 101.
- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide two year manufacturer warranty for all linear fluorescent ballasts.

1.10 EXTRA MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.
- B. Furnish two of each plastic lens type.
- C. Furnish one replacement lamps for each lamp type.
- D. Furnish two of each ballast type.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acuity Brands, Inc; : www.acuitybrands.com.
- B. Hubbell Lighting, Inc; : www.hubbelllighting.com.
- C. Lightolier: www.lightolier.com.
- D. Lithonia Lighting: www.lithonia.com.
- E. Columbia Lighting.
- F. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LUMINAIRES

- A. Manufacturers:
 1. Acuity Brands, Inc; : www.acuitybrands.com.
 2. Cooper Lighting, a division of Cooper Industries; : www.cooperindustries.com.
 3. Hubbell Lighting, Inc; : www.hubbelllighting.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Provide products that comply with requirements of NFPA 70.

- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- H. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 200,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- I. LED Luminaires: Listed and labeled as complying with UL 8750.
- J. Track Lighting Systems: Provide track compatible with specified track heads, with all connectors, power feed fittings, dead ends, hangers and canopies as necessary to complete installation.
- K. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.03 EMERGENCY LIGHTING UNITS

- A. Manufacturers:
 - 1. Acuity Brands, Inc; : www.acuitybrands.com.
 - 2. Cooper Lighting, a division of Cooper Industries; : www.cooperindustries.com.
 - 3. Hubbell Lighting, Inc; : www.hubbelllighting.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924. Emergency and Exit light combination unit with (2) unit mounted lamps and LED exit light with battery backup. This combination unit shall have spare capacity to power remote emergency lamp heads.
- C. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- D. Battery:
 - 1. Sealed maintenance-free nickel cadmium unless otherwise indicated.
 - 2.
 - 3. Size battery to supply all connected lamps, including emergency remote heads where indicated.
- E. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- F. Provide low-voltage disconnect to prevent battery damage from deep discharge.
- G. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

H. Accessories:

1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
2. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
3. Provide compatible accessory wire guards where indicated.
4. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.04 LUMINAIRES

- A. Furnish products as indicated in Schedule attached to this section.
- B. Substitutions: See Section 01 60 00 - Product Requirements.
 1. Input Voltage: 120 or 277 volts.

2.05 EXIT SIGNS

- A. Manufacturers:
 1. Acuity Brands, Inc; : www.acuitybrands.com.
 2. Cooper Lighting, a division of Cooper Industries; : www.cooperindustries.com.
 3. Hubbell Lighting, Inc; : www.hubbelllighting.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. All Exit Signs: Internally illuminated with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
 1. Number of Faces: Single or double as indicated or as required for the installed location.
 2. Directional Arrows: As indicated or as required for the installed location.
- C. Self-Powered Exit Signs:
 1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
 2. Battery: Sealed maintenance-free nickel cadmium unless otherwise indicated.
 3. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
 4. Provide low-voltage disconnect to prevent battery damage from deep discharge.
 5. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.
- D. Accessories:
 1. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
 2. Provide compatible accessory wire guards where indicated.
- E. Manufacturers: As indicated on lighting fixture schedule.
 1. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Exit Signs: Exit sign fixture .
 1. Housing: Plastic.
 2. Face: Translucent glass face with red letters on white background.
 3. Face: Aluminum stencil face with red letters.
 4. Directional Arrows: Universal type for field adjustment.
 5. Mounting: Universal, for field selection.
 6. Battery: 12 volt, nickel-cadmium type, with 1.5 hour capacity.
 7. Battery Charger: Dual-rate type, with sufficient capacity to recharge discharged battery to full charge within twelve hours.
 8. Lamps: Manufacturer's standard.

9. Input Voltage: 120/277 volts.

2.06 BALLASTS

- A. Manufacturers:
 1. General Electric Company/GE Lighting; : www.gelighting.com.
 2. Osram Sylvania; : www.sylvania.com.
 3. Philips Lighting Electronics/Advance; : www.advance.philips.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
 5. Manufacturer Limitations: Where possible, for each type of luminaire provide ballasts produced by a single manufacturer.
- B. All Ballasts:
 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
- C. Fluorescent Ballasts:
 1. All Fluorescent Ballasts: Unless otherwise indicated, provide high frequency electronic ballasts complying with ANSI C82.11 and listed and labeled as complying with UL 935.
 - a. Input Voltage: Suitable for operation at voltage of connected source, with variation tolerance of plus or minus 10 percent.
 - b. Total Harmonic Distortion: Not greater than 10 percent.
 - c. Power Factor: Not less than 0.95.
 - d. Thermal Protection: Listed and labeled as UL Class P, with automatic reset for integral thermal protectors.
 - e. Sound Rating: Class A, suitable for average ambient noise level of 20 to 24 decibels.
 - f. Lamp Compatibility: Specifically designed for use with the specified lamp, with no visible flicker.
 - g. Lamp Operating Frequency: Greater than 20 kHz, except as specified below.
 - 1) Do not operate lamp(s) within the frequencies from 30 kHz through 40 kHz in order to avoid interference with infrared devices.
 - h. Lamp Current Crest Factor: Not greater than 1.7.
 - i. Provide automatic restart capability to restart replaced lamp(s) without requiring resetting of power.
 - j. Provide end of lamp life automatic shut down circuitry for T5 and smaller diameter lamp ballasts.
 - k. Surge Tolerance: Capable of withstanding characteristic surges according to IEEE C62.41.2, location category A.
 - l. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 18, for Class A, non-consumer application.
 - m. Provide high efficiency T8 lamp ballasts certified as NEMA premium where indicated.
 - n. Ballast Marking: Include wiring diagrams with lamp connections.
 2. Non-Dimming Fluorescent Ballasts:
 - a. Lamp Starting Method:
 - 1) T8 Lamp Ballasts: Programmed start unless otherwise indicated.
 - 2) T5 Lamp Ballasts: Programmed start unless otherwise indicated.
 - 3) Compact Fluorescent Lamp Ballasts: Programmed start unless otherwise indicated.
 - b. Lamp Starting Temperature: Capable of starting standard lamp(s) at a minimum of 0 degrees F, and energy saving lamp(s) at a minimum of 60 degrees F unless otherwise indicated.

2.07 LAMPS

- A. Manufacturers:
 - 1. General Electric Company/GE Lighting; : www.gelighting.com.
 - 2. Osram Sylvania; : www.sylvania.com.
 - 3. Philips Lighting Company; : www.lighting.philips.com.
 - 4. Philips Lighting Co of NA: www.lighting.philips.com.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. All Lamps:
 - 1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
 - 2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
 - 3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
 - 4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.
- C. Compact Fluorescent Lamps: Wattage and bulb type as indicated, with base type as required for luminaire.
 - 1. Low Mercury Content: Provide lamps that pass the EPA Toxicity Characteristic Leaching Procedure (TCLP) test for characteristic hazardous waste.
 - 2. Correlated Color Temperature (CCT): 3,500 K unless otherwise indicated.
 - 3. Color Rendering Index (CRI): Not less than 80.
 - 4. Average Rated Life: Not less than 10,000 hours for an operating cycle of three hours per start.
- D. Linear Fluorescent Lamps: Wattage and bulb type as indicated, with base type as required for luminaire.
 - 1. Low Mercury Content: Provide lamps that pass the EPA Toxicity Characteristic Leaching Procedure (TCLP) test for characteristic hazardous waste.
 - 2. T8 Linear Fluorescent Lamps:
 - a. Correlated Color Temperature (CCT): 3,500 K unless otherwise indicated.
 - b. Color Rendering Index (CRI): Not less than 80.
 - c. Average Rated Life: Not less than 20,000 hours for an operating cycle of three hours per start.
 - 3. T5 Linear Fluorescent Lamps:
 - a. Correlated Color Temperature (CCT): 3,500 K unless otherwise indicated.
 - b. Color Rendering Index (CRI): Not less than 80.
 - c. Average Rated Life: Not less than 20,000 hours for an operating cycle of three hours per start.
- E. Lamp Types: As specified for each luminaire.
- F. Fluorescent Lamps:
 - 1. Product: Phillips Lighting - Type T5 or T8.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- G. High Intensity Discharge (HID) Lamps:
 - 1. Product: Match Lighting Fixture Type
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.08 ACCESSORIES

- A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.

- B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.
- C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.
- D. Tube Guards for Linear Fluorescent Lamps: Provide clear virgin polycarbonate sleeves with endcaps where indicated.
- E. Product: As indicated in lighting fixture schedule.
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure pendant-mounted luminaires to building structure.
 - 4. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 5. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gage, connected from opposing corners of each recessed luminaire to building structure.
 - 6. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- F. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
 - 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
 - 3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- G. Suspended Luminaires:

1. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
2. Install canopies tight to mounting surface.

H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

- I. Install fixtures securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).
- J. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.
- K. Support luminaires independent of ceiling framing.
- L. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
- M. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- N. Exposed Grid Ceilings: Support surface mounted luminaires in grid ceiling directly from building structure.
- O. Exposed Grid Ceilings: Provide auxiliary members spanning ceiling grid members to support surface mounted luminaires.
- P. Exposed Grid Ceilings: Fasten surface mounted luminaires to ceiling grid members using bolts, screws, rivets, or suitable clips.
- Q. Install recessed luminaires to permit removal from below.
- R. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- S. Install clips to secure recessed grid-supported luminaires in place.
- T. Install wall mounted luminaires, emergency lighting units, and exit signs at height as scheduled.
- U. Install accessories furnished with each luminaire.
- V. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- W. Bond products and metal accessories to branch circuit equipment grounding conductor.
- X. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.
- Y. Air Handling Luminaires: Interface with air handling accessories furnished and installed under Section 23 36 00.

Z. Emergency Lighting Units:

1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

AA. Exit Signs:

1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

AB. Install lamps in each luminaire.

AC. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.

- B. Inspect each product for damage and defects.
- C. Perform field inspection, testing, and adjusting in accordance with Section 01 4000.
- D. Operate each luminaire after installation and connection to verify proper operation.
- E. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.
- F. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.
- C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.
- D. Aim and adjust luminaires as indicated.
- E. Position exit sign directional arrows as indicated.

3.06 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.
- B. Clean electrical parts to remove conductive and deleterious materials.
- C. Remove dirt and debris from enclosures.
- D. Clean photometric control surfaces as recommended by manufacturer.
- E. Clean finishes and touch up damage.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

3.09 PROTECTION

- A. Relamp luminaires that have failed lamps at Substantial Completion.

3.10 SCHEDULE - ATTACHED

END OF SECTION

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Exterior luminaires.
- B. Ballasts.
- C. Lamps.
- D. Poles and accessories.
- E. Luminaire accessories.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for poles.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 37 - Boxes.
- D. Section 26 27 26 - Wiring Devices: Receptacles for installation in poles.
- E. Section 26 28 13 - Fuses.
- F. Section 26 51 00 - Interior Lighting.

1.03 REFERENCE STANDARDS

- A. AASHTO LTS - Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals; American Association of State Highway and Transportation Officials.
- B. ANSI O5.1 - American National Standard for Wood Poles -- Specifications and Dimensions.
- C. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information.
- D. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules.
- E. IESNA LM-64 - Photometric Measurements of Parking Areas.
- F. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- G. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems.
- H. NFPA 70 - National Electrical Code.
- I. UL 1598 - Luminaires.
- J. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
 - 2. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. Provide photometric calculations where luminaires are proposed for substitution .
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.
 3. Lamps: Include rated life and initial and mean lumen output.
 4. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.
- D. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.
- E. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 60 00 - Product Requirements, for additional provisions.
- I. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.
- C. Receive, handle, and store wood poles in accordance with ANSI O5.1.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Acuity Brands, Inc; : www.acuitybrands.com.
- B. Hubbell Lighting, Inc; : www.hubbelllighting.com.
- C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the Drawings.
- B. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 LUMINAIRES

- A. Manufacturers:
 - 1. Acuity Brands, Inc; : www.acuitybrands.com.
 - 2. Hubbell Lighting, Inc; : www.hubbelllighting.com.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Provide products that comply with requirements of NFPA 70.
- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- H. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.
- I. LED Luminaires: Listed and labeled as complying with UL 8750.
- J. Exposed Hardware: Stainless steel.

2.04 BALLASTS

- A. Manufacturers:
 - 1. General Electric Company/GE Lighting; : www.gelighting.com.
 - 2. Osram Sylvania; : www.sylvania.com.
 - 3. Philips Lighting Electronics/Advance; : www.advance.philips.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. All Ballasts:
 - 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 - 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

2.05 LAMPS

- A. Manufacturers:
 - 1. General Electric Company/GE Lighting; : www.gelighting.com.
 - 2. Osram Sylvania; : www.sylvania.com.
 - 3. Philips Lighting Company; : www.lighting.philips.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

- B. All Lamps:
 - 1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
 - 2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
 - 3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
 - 4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.

2.06 POLES

- A. Manufacturers:
 - 1. Acuity Brands, Inc; : www.acuitybrands.com.
 - 2. Hubbell Lighting, Inc; : www.hubbelllighting.com.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. All Poles:
 - 1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
 - 2. Structural Design Criteria:
 - a. Comply with AASHTO LTS.
 - b. Wind Load: Include effective projected area (EPA) of luminaire(s) and associated supports and accessories to be installed.
 - 1) Design Wind Speed: 100 miles per hour, with gust factor of 1.3.
 - c. Dead Load: Include weight of proposed luminaire(s) and associated supports and accessories.
 - 3. Material: Steel, unless otherwise indicated.
 - 4. Shape: Square straight, unless otherwise indicated.
 - 5. Finish: Match luminaire finish, unless otherwise indicated.
 - 6. Mounting: Install on concrete foundation, height as indicated on the drawings, unless otherwise indicated.
 - 7. Unless otherwise indicated, provide with the following features/accessories:
 - a. Top cap and metallic base cover.
 - b. Handhole.
 - c. Anchor bolts with leveling nuts or leveling shims.
 - d. Anchor base cover.
 - e. Pole-top tenon, size as required for installed luminaire or bracket.
- C. Metal Poles: Provide ground lug, accessible from handhole or transformer base.

2.07 ACCESSORIES

- A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.
- B. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.

- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Recessed Luminaires:
 1. Install trims tight to mounting surface with no visible light leakage.
 2. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- F. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- G. Install accessories furnished with each luminaire.
- H. Bond products and metal accessories to branch circuit equipment grounding conductor.
- I. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.06 CLEANING

- A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- D. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 27 10 05
STRUCTURED CABLING FOR VOICE AND DATA - INSIDE-PLANT

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Communications system design requirements.
- B. Communications pathways.
- C. Fiber optic cable and interconnecting devices.
- D. Communications equipment room fittings.
- E. Communications outlets.
- F. Communications grounding and bonding.
- G. Communications identification.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 37 - Boxes.

1.03 REFERENCE STANDARDS

- A. ICEA S-83-596 - Indoor Optical Fiber Cables.
- B. NFPA 70 - National Electrical Code.
- C. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices.
- D. TIA-492AAAD - Detail Specification for 850-nm Laser-Optimized, 50- μ m Core Diameter/125- μ m Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; Telecommunications Industry Association.
- E. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant.
- F. TIA-568-C.3 - Optical Fiber Cabling Components Standard.
- G. TIA-598-D - Optical Fiber Cable Color Coding.
- H. TIA-607-C - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- I. UL 444 - Communications Cables.
- J. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
- K. UL 1651 - Fiber Optic Cable.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
 2. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 3. Notify Architect/Engineer of any conflicts with or deviations from the contract documents.
Obtain direction before proceeding with work.
 4. Coordinate requirements of this section with Owner.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

- C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
- D. Evidence of qualifications for installer.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- F. Field Test Reports.
- G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 - 1. Record actual locations of outlet boxes and distribution frames.
 - 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 - 3. Identify distribution frames and equipment rooms by room number on contract drawings.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.
- B. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
 - 1. Supervisors and installers factory certified by manufacturers of products to be installed.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 2 year period after Date of Substantial Completion.
- C. Provide warranty as called out in applicable referenced State of Delaware standards/specifications

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
- B. **IMPORTANT!! PLEASE NOTE THAT this specification references the Delaware State-Wide Information And Architecture Standards, Standard ID: NE=Cabling-002, Title: Structured Cabling System Standards and Specifications for State-Managed Facilities, Domain: Network and Storage, Discipline: Cabling, Revision Date: 1/8/2016, Revision no.: 6, Original date: 7/21/2008. As such this document shall be considered as part of this specification. Unless otherwise shown and or specified, all work, materials, etc. called for in the above mentioned document shall be provided as shown and specified the above mentioned document and on the drawings.**

2.02 PATHWAYS

- A. Refer to above mentioned Delaware State-Wide Information And Architecture Standards as well as other project specifications and drawings.

2.03 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

- A. Fiber Optic Backbone Cable:
 - 1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568-C.3, TIA-598-D, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
 - 2. Cable Type: Multimode, laser-optimized 50/125 um (OM4) complying with TIA-492AAAD.
 - 3. Cable Capacity: 12-fiber.
 - 4. Cable Applications:
 - a. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.
 - 5. Cable Jacket Color:
 - a. Laser-Optimized Multimode Fiber (OM3/OM4): To be selected by Owner.
 - 6. Product(s):
 - a. Hubbell M/N HFCD15012P4 or approved equal.
- B. Fiber Optic Interconnecting Devices:
 - 1. Connector Type: Type SC.
 - 2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
 - 3. Maximum Attenuation/Insertion Loss: 0.3 dB.
 - 4. Product(s):
 - a. Hubbell M/N FSPSCDM6AQ or approved equal. Provide 1 of these per 2U fiber patch panel box.
 - b. Provide 5 blanks per 2U fiber patch panel box. Hubbell M/N FSPB or approved equal

2.04 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

- A. Refer to above mentioned Delaware State-Wide Information And Architecture Standards as well as other project specifications and drawings.

2.05 COMMUNICATIONS OUTLETS

- A. Refer to above mentioned Delaware State-Wide Information And Architecture Standards as well as other project specifications and drawings.
- B. Outlet Boxes: Comply with Section 26 05 37.
 - 1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
- C. Wall Plates:
 - 1. Comply with system design standards and UL 514C.
 - 2. Accepts modular jacks/inserts.
 - 3. Capacity:

2.06 GROUNDING AND BONDING COMPONENTS

- A. Refer to above mentioned Delaware State-Wide Information And Architecture Standards as well as other project specifications and drawings.
- B. Comply with TIA-607-C.

2.07 IDENTIFICATION PRODUCTS

- A. Identification shall be as specified and directed by Owner at no additional cost to the Owner

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Comply with Communication Service Provider requirements.
- B. Grounding and Bonding: Perform in accordance with TIA-607-C and NFPA 70.
- C. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

- D. Refer to above mentioned Delaware State-Wide Information And Architecture Standards as well as other project specifications and drawings.

3.02 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
 - 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 - 2. Do not over-cinch or crush cables.
 - 3. Do not exceed manufacturer's recommended cable pull tension.
 - 4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
- B. Identification:
 - 1. Use wire and cable markers to identify cables at each end.
 - 2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
 - 3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.
 - 4. Identify components as directed by Owner at no additional cost to Owner.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Comply with inspection and testing requirements of specified installation standards.
- C. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.
- D. Testing - Copper Cabling and Associated Equipment:
 - 1. Test backbone cables after termination but before cross-connection.
 - 2. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
 - 3. Test operation of shorting bars in connection blocks.
 - 4. Category 3 Backbone: Perform attenuation test.
 - 5. Category 3 Links: Test each pair for short circuit continuity, short to ground, crosses, reversed polarity, operational and ring-back, and dial tone.
 - 6. Category 5e and Above Backbone: Perform near end cross talk (NEXT) and attenuation tests.
 - 7. Category 5e and Above Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.
 - 8. Refer to above mentioned Delaware State-Wide Information And Architecture Standards as well as other project specifications and drawings.
- E. Testing - Fiber Optic Cabling:
 - 1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
 - 2. Multimode Backbone: Perform tests in accordance with TIA-526-14.
 - 3. Links: Perform optical fiber end-to-end attenuation tests and field reel tests.
 - 4. Refer to above mentioned Delaware State-Wide Information And Architecture Standards as well as other project specifications and drawings.

END OF SECTION

SECTION 27 51 17
PUBLIC ADDRESS SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Amplifier and control equipment.
- B. Input equipment.
- C. Sound system cable.

1.02 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code.

1.03 SYSTEM DESCRIPTION

- A. Public address system for voice and music.
- B. Input components:
 - 1. Compact disc player.
 - 2. AM/FM tuner.
 - 3. Microphone.
- C. Features:
 - 1. Interface to telephone system.
 - 2. One-way paging by zone.
 - 3. Distribution of background music.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate electrical characteristics and connection requirements. Indicate layout of equipment mounted in racks and cabinets, component interconnecting wiring, and wiring diagrams of field wiring to speakers and remote input devices.
- C. Product Data: Provide data showing electrical characteristics and connection requirements for each component.
- D. Test Reports: Indicate satisfactory completion of each test recommended by the manufacturer.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- G. Manufacturer's Field Reports: Indicate that installation is complete and system performs according to specified requirements.
- H. Project Record Documents: Record actual locations of speakers, control equipment, and outlets for input/output connectors.
- I. Operation Data: Include instructions for adjusting, operating, and extending the system.
- J. Maintenance Data: Include repair procedures and spare parts documentation.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70 and Federal Communications Commission.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.

- C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- D. Installer Qualifications: Authorized installer of specified manufacturer with service facilities within 50 miles of Project.
- E. Products: Listed, classified, and labeled as suitable for the purpose intended.
- F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Bogen Communications, Inc: www.bogen.com.
- B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 AMPLIFICATION AND CONTROL EQUIPMENT

- A. The amplifier shall be a model GS250D, rated at 250 watts RMS with manufacturer provided rack mounting hardware.
- B. The amplifier shall accommodate up to 6 Lo-Z balanced microphones, 2 Hi-Z auxiliary sources and a telephone paging input (MIC 5 shall be switch-selected for MIC or telephone line; MIC 6 switch-selected for MIC or AUX 1). MIC 1 through 4 shall use XLR-type connectors; AUX inputs shall be via RCA phono jacks and all other connectors shall use pluggable screw terminals. Phantom power shall be supplied for use with condenser microphones. Microphone precedence connections shall be included for MIC 1, 2, 3, 5/TEL, 6/AUX 1 and AUX 2.
- C. The amplifier shall provide a frequency response from 65 Hz to 20 kHz +0/-2 dB at rated power. Distortion shall be 0.3% typically.
- D. The amplifier shall include an Audio Enhancement circuit, variable loudness contour control, and dual function equalizer. The equalizer shall be switch selectable for feedback control or acoustic shaping and shall include 10 center-detent slide controls providing ±12 dB of boost or cut from 62.5 Hz to 16 kHz in acoustic mode and from 125Hz to 8 kHz in feedback control mode.
- E. The amplifier shall include automatic level control to provide consistent output regardless of who is paging, automatic muting complete with a VOX circuit, and a variable mute level. Provisions shall also be included for remote volume control, using an accessory control unit (GSRVC).
- F. Outputs shall be provided for 4- and 8-ohm speakers and for 25V, 25VCT and 70V distributed systems. Additional outputs shall be provided to feed a booster amp and recorder. A dedicated output shall permit feeding a 600-ohm telephone line using an accessory transformer (Model WMT1A). A Pre-Amp Out/Power-Amp In circuit shall be provided to insert signal processing equipment.
- G. The amplifier shall be rack mountable using an accessory rack panel kit (GSDRPK). It shall carry the necessary safety agency listings for both the US and Canada.

2.03 COMPONENTS

- A. CD Player and AM/FM Receiver:
 - 1. The auxiliary program source shall be a Bogen Model CDR1 CD Player with AM/FM Receiver, or equivalent.
 - 2. The program source shall include manual tuning and auto seek control. The auto seek control shall automatically ascend (or descend) the frequency scale to the next strong frequency. It shall be possible to program up to 5 bands (FM1, FM2, FM3, AM1, AM2) with up to 6 stations each for a total of 30 stations. A preset scan control shall be provided to scroll and select from available presets. The FM section shall have a frequency range from

87.5 MHz - 108 MHz, the AM section will have a frequency range of 530 kHz - 1710 kHz. Pluggable screw terminal inputs shall be available for an AM loop antenna, a FM dipole antenna, and for speaker outputs. An F-type coax antenna connector shall also be available.

3. The CD player system shall include Browse, Repeat, Random Play, and Pause functions. The CD player shall be capable of playing CD, CD-R, or CD-RW discs (including MP3 files).
4. The CDR1 shall have a frequency response of 20 Hz - 20 kHz (< 5 dB).
5. The following controls shall be provided: Power/ Volume, Disc Eject, Mode (Radio, CD, AUX), Audio/Menu Select (Volume, Bass, Treble, Balance, Display, Seek, and Clock), Mute, Scan, Stereo/Mono, Station Store/Select, Loudness Contour, Band, and Station Select. An LCD digital readout shall be provided to show selected frequency and band (in Radio Mode) or track (in CD Mode) information.
6. The unit shall operate on 12V DC (3A) power with an included desktop-style AC power adapter. It shall be possible to drive 8-ohm loudspeakers directly from 1W per channel (Right/Left) outputs. A 50-ohm mono-summed RCA output shall also be available, in addition to stereo.
7. The unit shall be 7-1/4" W x 2-1/8" H x 9-1/4" D and shall weigh 4 lb. The unit shall mount in a standard 19-inch rack system (2 rack spaces high) with the RK78 rack mounting kit.

B. Microphone: Desk type low impedance microphone with push-to-talk switch.

1. Product: Bogen DDU250 or approved equal.
2. Microphone Preamplifier: Provide RDL EZ-MPA1 or approved equal to connect microphone to and boost signal for it to the PA amplifier.
3. Substitutions: See Section 01 60 00 - Product Requirements.

C. Speakers w/volume control

1. Product: Refer to Drawings.
2. Substitutions: See Section 01 60 00 - Product Requirements.

D. Speaker Baffles and Enclosure: Square, painted steel, with uniform perforations, and volume control

1. Product: Refer to Drawings.
2. Substitutions: See Section 01 60 00 - Product Requirements.

E. Horns: Wide dispersion indoor/outdoor horn with driver.

1. Product: Refer to Drawings.
2. Substitutions: See Section 01 60 00 - Product Requirements.

F. Telephone Interface: 600 ohm - auxiliary input.

1. Product: Refer to Drawings.
2. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 WIRE AND CABLE

- A. Microphone Cord: 20 AWG stranded copper conductor, 600 volt insulation, rated 60 degrees C, two conductor shielded cable with rubber jacket. Cable shall be plenum rated.
- B. Input Cable: 22 AWG copper conductor, 300 volt insulation, rated 60 degrees C, paired conductors twisted together, shielded, and covered with a PVC jacket. Cable shall be plenum rated.
- C. Plenum Cable for Speaker Circuits: 22 AWG copper conductor, 300 volt insulation, rated 200 degrees C, paired conductors twisted together shielded and covered with a nonmetallic jacket; suitable for use for Class 2 circuits in air handling ducts, hollow spaces used as ducts, and plenums.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Splice cable only in accessible junction boxes or at terminal block units.
- C. Make cable shields continuous at splices and connect speaker circuit shield to equipment ground only at amplifier.
- D. Install input circuits in separate cables and raceways from output circuits.
- E. Leave 18 inches excess cable at each termination at microphone, volume pad, speaker, and other system outlet.
- F. Leave 6 feet excess cable at each termination at system cabinet
- G. Provide protection for exposed cables where subject to damage.
- H. Use armored cable for outside speaker circuits.
- I. Support cables above accessible ceilings to keep them from resting on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure for ceiling suspension system. Include bridle rings or drive rings.
- J. Use suitable cable fittings and connectors.
- K. Connect reproducers to amplifier with matching transformers.
- L. Ground and bond equipment and circuits in accordance with Section 26 05 26.
- M. Provide all required appropriate cabling to connect microphone preamplifier to amplifier. Cabling shall be plenum rated and run concealed in walls, above ceilings, and in conduit (if exposed).

3.02 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Provide the services of manufacturer's technical representative to prepare and start system.
 - 1. Include making of final wiring connections, inspection and adjusting of completed installation, and systems demonstration.
 - 2. Certify that installation is complete and performs according to specified requirements.
- C. Measure and record sound power levels at designated locations.

3.03 ADJUSTING

- A. Adjust transformer taps and volume controls for appropriate sound level.
- B. Adjust devices and wall plates to be flush and level.

3.04 CLOSEOUT ACTIVITIES

- A. See Section 01 79 00 - Demonstration and Training, for additional requirements.
- B. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.
- C. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

- D. Owner Requested Volume Adjustements: Provide 16 hours of contractor personnel time to adjust speaker volume as directed by Owner.

3.05 MAINTENANCE

- A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of public address and music system for one year from Date of Substantial Completion.

END OF SECTION

SECTION 27 51 20
GYM & CAFETERIA AUDIOVISUAL REINFORCEMENT SYSTEM

PART 1-GENERAL**1.01 GENERAL PROVISIONS**

- A. Applicable provisions of the entire specification, including Addenda, shall govern this section as fully as if repeated herein.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. The contractor shall furnish all equipment, accessories and material required for the installation of a comprehensive professional A/V system for the Gym & Cafeteria in strict compliance with these specifications and applicable contract drawings. Any material and/ or equipment necessary for the proper operation of the system, which is not specified or described herein, shall be deemed part of this specification.

1.03 QUALITY ASSURANCE

- A. Codes and Standards: Provide products and materials conforming to the following:
 1. Electronic Industries Association (EIA): Comply with the following EIA standards:
 - a. RS-160 Sound Systems
 - b. RS-299-A Loudspeakers, Dynamic Magnetic Structures and Impedance
 - c. RS-310-C Racks, Panels & Associated Equipment
 - d. SE-101-A Amplifiers for Sound Equipment
 - e. SE-103 Speakers for Sound Equipment
 2. National Fire Protection Association (NFPA): Provide work complying with applicable requirements of NFPA 70 "National Electrical Code" including, but not limited to the following:
 - a. Article 250 Grounding
 - b. Article 300 Part A. Wiring Methods
 - c. Article 310 Conductors for General Wiring
 - d. Article 725 Remote Control, Signaling Circuits
 - e. Article 800 Communication Systems
 3. Comply with requirements of Underwriters Laboratories, Inc. (UL) 50. "Cabinets and Boxes."
- B. Certification: Provide certificate of compliance with the referenced standards from the equipment manufacturer.

1.04 SUBMITTALS

- A. Provide submittals as follows:
 1. Shop drawings: Provide a floor plan diagram of the system installation details, indicating device locations, component wiring, proposed wire routing, rough-in and all other installation information. Provide wiring diagrams for all field devices and riser diagram of system layout.
 2. Provide complete catalog data sheets of all major components, including but not limited to:
 - a. Integrated speaker control and fire alarm communication, equipment racks and equipment.
 - b. Entire Products identified in this specification.
 - c. Backboxes and specialty rough-ins.
 - d. Wire, cable, jacks and termination fields.

1.05 CONTRACTOR QUALIFICATIONS

- A. The work of this section shall be performed by a dedicated A/V system contractor to supply the equipment, design, supervise and complete final checkout and certification procedures.
- B. The A/V contractor shall be a factory authorized sales and service distributor of the specified equipment, and must provide with his submittals manufacturer documentation stating that they are in fact authorized distributors of the specified equipment.
- C. Provide installation supervision by personnel, who are factory authorized service representatives of the specified equipment manufacturer and who currently provide maintenance service for equipment of the type specified.

1.06 APPROVED EQUIPMENT

- A. This specification is based upon equipment produced by various manufacturers. The local system integrator authorized manufacturer's representative for all products is B & B Sound, Inc. Contact Roy Voshell at (302) 697-2155.
- B. Substitute manufacturers and integrators shall submit documentation for approval a minimum of 10 days prior to the date bids are due. Documentation shall include, a 3D model of proposed speaker locations and aiming, three acoustic models showing Direct SPL, C50, and STI measurements in the listener area, and a proposed BSS Audio Architect processing and control file. Performance must be equal to or better than the specified system for a substitution to be allowed
- C. The System Integrator shall perform all start up services; supervision during installation and testing and final acceptance.
- D. System Integrator shall be a Factory Authorized Dealer for BSS Soundweb products and have a BSS certified programmer on staff.

1.07 GENERAL

- A. The intent of this specification is to provide a complete and satisfactory operating system for the pickup, amplification, distribution and reproduction of voice and other audio program material. All equipment and installation material required to fulfill the above shall be furnished whether or not specifically enumerated herein or on the drawings. All necessary hookup and installation shall be by a factory approved representative. The installation supervisor shall also instruct the personnel designated by the owner as to correct operation of the system. A minimum of 4 hours of time for this shall be included in the bid.
- B. The contractor shall provide three complete sets of the following data, upon completion: installation wiring diagrams, complete instruction manuals, schematic drawings and service instructions.
- C. The system shall be guaranteed for a period of one year from the date of substantial completion, against defective materials, design and installation. Any defects shall be repaired/replaced at no expense to the owner during normal business hours.
- D. The work herein specified shall be performed by fully competent workmen, in a thorough manner. All materials furnished by the contractor shall be new, and all work shall be completed to the satisfaction of the architect, engineer and owner.
- E. At the time of submittal, the contractor shall submit a complete and accurate listing of all major items of equipment to be used in assembling the system, including all items of equipment listed under this specification, as well as contractor's block diagrams indicating the proposed interconnection of all equipment to be furnished. All modifications of standard equipment necessary to meet specifications shall be explained fully and must be accompanied by schematic diagrams.

- F. All equipment, except portable equipment, shall be held firmly in place. This shall include loudspeakers, amplifiers, cables, etc. Fastenings and supports shall be adequate to support their loads with a safety factor of at least five (5). All switches, connectors, outlets, cables, etc., shall be clearly, logically and permanently marked during installation.
- G. The contractor must take such precautions as are necessary to guard against electromagnetic and electrostatic hum, to supply adequate ventilation and to install the equipment so as to provide minimum safety to the person who operates it.
- H. Care shall be exercised in wiring so as to avoid damage to the cables and to the equipment. All joints and connections shall be made with rosin-core solder or with mechanical connectors approved by the engineer. All wiring shall be executed in strict adherence to standard broadcast practices.
- I. The contractor shall submit to the engineer a "certificate of completion" to assure that the system has passed all the tests required in subsequent part of this specification and is in proper operating condition. Final tests shall be made in the presence of the system specifier, who shall be notified of the test date a minimum of five (5) days prior to that date.
- J. All wiring shall be installed concealed in ceiling spaces and walls. Wiring shall be run in bridle rings spaced a maximum of 6 feet apart or rigid conduit. Where wiring must be run down walls exposed, or installed in areas without a suspended acoustic ceiling, Contractor shall run wiring in EMT conduit unless otherwise shown, stated, or authorized by Architect/Engineer.

1.08 SYSTEM DESCRIPTION

- A. The professional A/V system shall consist of equipment as detailed in the bill of materials. It shall include 2 Professional UHF Diversity Wireless Systems, 4 inputs and 2 outputs via XLR connectors in pockets located in the risers of the stage steps, 2 synergy horn loudspeakers mounted appropriately in the space as to provide ideal coverage in the audience area, BSS system processing and control, and a 17' 16:10 rear projection screen with an Eiki 10,000 or greater ANSI lumen laser projector.
- B. Provide interface with main school intercommunications system to allow emergency interruption of local program material and broadcasting of intercommunications system audio source.

PART 2 -PRODUCTS

2.01 SEE BILL OF MATERIALS BELOW PART 3 -EXECUTION

PART 3 - EXECUTION

3.01 INSTALLER'S RESPONSIBILITIES

- A. The installer shall coordinate the installation of the A/V equipment with the manufacturer's authorized representative.
- B. All conductors and wiring shall be installed according to the manufacturer's recommendations.
- C. It shall be the Installer's responsibility to coordinate with the supplier, regarding the correct wiring procedures before installing any conduits or conductors.
- D. Electrical contractor shall provide all 120VAC circuits as required by the sound system vendor at no additional cost to the Owner.

3.02 3.2 INSTALLATION OF SYSTEM COMPONENTS

- A. System components shall be installed in accordance with the latest revisions of the appropriate NFPA pamphlets, the requirements contained herein, National Electrical Code, local and state regulations, and other applicable authorities having jurisdiction (AHJ).
- B. All wiring shall be type designed for use in A/V systems. All A/V system cable shall be installed above the acoustic ceiling or contained in building walls. Where a device is mounted on a masonry wall, install conduit stub within wall from device backbox to top of wall. All wiring shall

be concealed and all backboxes recessed, where possible. Coordinate exact conduit routing, type and method with the owner's representative and receive approval prior to installation. "ALL" wiring and or cabling shall be plenum rated.

- C. Where wiring is run above acoustic ceiling space, install cables in bridle rings connected to the building steel supports. Install bridle rings every 6 feet. Cables shall not be tie-wrapped to any pipes. Provide separate cable runs for speaker and microphone cables. These circuit wires cannot be installed within the same bundle of wires.
- D. Raceway containing conductors identified as "A/V System" conductors shall not contain any other conductors and no AC current carrying conductors shall be allowed in the same raceway with the DC fire alarm detection and signaling conductors.
- E. It shall be the responsibility of the contractor to coordinate the exact location of all installed equipment with all applicable trades.

3.03 WARRANTY

- A. The contractor shall leave the A/V system in proper working order, and without additional expense to the owner, shall replace any defective materials or equipment provided by them under this contract within one (1) year from the date of Substantial Completion. Warranty work shall be completed during normal business hours, a maximum of 24 hours after notification of the service request.

3.04 FINAL TEST

- A. Before the installation shall be considered complete and acceptable by the awarding authority, a test on the system shall be performed as follows:
 - 1. The contractor's job foreman, in the presence of a representative of the owner and audiovisual specifier, shall operate all aspects of the sound system to ensure proper performance, correct audio duplication, and installation in compliance with industry standard practices.

3.05 AS-BUILT DOCUMENTATION

- A. As part of the close out documentation for the project, provide as-built drawings to indicate actual locations of components installed that are called for by this specification. Refer to section 01 17 00 for close-out documentation requirements.

3.06 OPERATING & MAINTENANCE MANUALS

- A. As part of the close out documentation for the project, provide all applicable O&M manuals and documentation for all components called for by this specification. Refer to section 01 17 00 for close-out documentation requirements.

3.07 INSTRUCTION OF OWNER'S PERSONNEL

- A. Upon completion of the formal check-out, the audiovisual contractor shall demonstrate operation and maintenance of the system to the owner's representatives. Training shall be conducted in two (2) two hour sessions on separate days (total 4 hours).

Caesar Rodney New Elementary School AV System

Bill of Materials

Manufacturer	Model	Quantity	Description
Danley Sound Labs	SH69I	1	Synergy Horn High Output Loudspeaker Custom Color
Danley Sound Labs	SM96	1	Synergy Horn High Output Loudspeaker Custom Color
Danley Sound Labs	DNA 20K4 PRO	1	High Output Power Amplifier with Danley DSP
Danley Sound Labs	BRKT-69	1	Bracket for SH69

Danley Sound Labs	BRKT-M96	1	Bracket for SM96
BSS	BLU-100	1	AV System Processor and Controller
BSS	BLU-10	1	Programable System Controller Panel
Audio Technica	ATW-3212/C710	2	Professional Diversity Wireless Microphone
Audio Technica	ATW-CHG3	1	Microphone Charging Dock
Middle Atlantic	DWR-21-22PD	1	21 Space Swinging Wall Mount Equipment
Middle Atlantic	AFACE3GANG3	1	Rack Blank for Mounting BLU-10 Controller
Middle Atlantic	D3	2	Rack Drawers
Middle Atlantic	AFACE2GANG1	1	Rack Blank for Mounting HDMI Plate
Furman	CN-2400S	1	Power Conditioner
Eiki	EK-820U Install Pack	1	High Definition 10,000 ANSI Lumen Laser Projector w/ Mount
Eiki	CUSTOM	1	Custom Eiki Lens for EK-820U
Kramer	DIP-30	1	HDMI Switcher with Audio De-Embedder
Kramer	WP-H1M	2	HDMI Passive Wall Plate
Kramer	BC-DGKAT623-305	AR	Heavy Duty Plenum CAT6 Shielded Twisted Pair Cable
Kramer	C-HM/HM-15	2	Professional HDMI Cable
Yamaha	DXR10	2	Powered Monitor Loudspeaker with Onboard DSP
Mystery Electronics	Floor Pockets	2	Stair Riser Mounted I/O Boxes
Mystery Electronics	Floor Pocket Inserts	AR	I/O Inserts for Stair Riser Mounted I/O Boxes
Rapco	Plates	AR	Wall Mounted Input Plates
Rapco	Plates	AR	Wall Mounted Output Plates
Netgear	GS108 PE	AR	POE Network Switch for Control Network
A/V Contractor	RF	AR	Material to Remote Mount Wireless Antennae
A/V Contractor	Mounting	AR	Grade 8 Mounting Hardware for Speakers
Chief	Mounting	AR	Mount for Projector
Rapco	Interconnect	AR	Interconnect Cabling
Kramer	RJ-45	AR	ISTP Cable Terminators
West-Penn	25291	AR	22 GA Plenum Microphone Wire
West-Penn	25226B	AR	14 GA Plenum Speaker Wire
Shure	SM58S	4	Switched Professional Cardioid Vocal Mic
Audio Technica	AE5100	2	Professional Cardioid Condenser Choir Mic
Tama	MS205BK	6	Professional Heavy Duty Boom Stand
Rapco	N1M125	10	Professional Mic Cable with Neutrik Ends
Rapco	DB1	2	Professional Metal Direct Box
Rapco	LTIBLOX	2	Laptop interface block

Da-Lite 35261C Custom 17' 1 Tensioned Rear Projection Screen

END OF SECTION

SECTION 27 53 13
WIRELESS CLOCK SYSTEM

GENERAL**1.01 SUMMARY OF WORK**

- A. This Section specifies materials and accessories for a wireless clock system.
- B. Section Includes:
 - 1. Master clock;
 - 2. Elapsed timer control panel;
 - 3. Repeaters;
 - 4. Secondary analog clock.

1.02 REFERENCE STANDARDS

- A. Federal Communications Division (FCC)

PART 15 - CODE OF FEDERAL REGULATIONS.**2.01 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA).**

- A. NFPA 70E-[2012], Standard for Electrical safety in the Workplace.
- B. US Green Building Council (USGBC).
 - 1. LEED® NC Version 2.2-[2009], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package for New Construction and Major Renovations.
- C. Underwriter's Laboratories (UL).
 - 1. UL

2.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this Section with communications and electronics work and with work of other trades for proper time and sequence to avoid construction delays.

2.03 ACTION AND INFORMATIONAL SUBMITTALS

- A. Make submittals in accordance with Contract Conditions and Section 01 30 00 - Submittal Procedures.
- B. Product Data: Submit product data including manufacturer's literature for clock system materials and accessories, indicating compliance with specified requirements and material characteristics.
 - 1. Submit list on clock system manufacturer's letterhead of materials and accessories to be incorporated into Work.
 - 2. Include product name.
 - 3. Include preparation instructions and recommendations, installation methods, and storage and handling requirements.
 - 4. Include contact information for manufacturer and their representative for this Project.
- C. Shop Drawings: Submit shop drawings with information as follows:
 - 1. Diagram of proposed system showing system platform appliance, communication pathway, and schedule of individual device locations.
 - 2. Indicate integration with the Owner's network and servers. Include line diagram of network relationships.
 - 3. Show system power requirements.
- D. Samples:
 - 1. Submit one sample of each type of device used on project. Samples will be returned Contractor for incorporation into the Work after Consultant's review.

- E. Test Reports:
 - 1. Submit evaluation and test reports or other independent testing agency reports showing compliance with specified performance characteristics and physical properties.
- F. Subcontractor Experience: Submit verification of communication and electronics subcontractor's experience.
- G. Manufacturer's Authorization: Submit verification of communication and electronics subcontractor's authorization from clock system manufacturer to perform Work of this section.

2.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Supply maintenance data for clock system for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- B. Record Documentation: In accordance with Section 01 78 00 - Closeout Submittals.
 - 1. List materials used in clock system work.
 - 2. Warranty: Submit warranty documents specified.

2.05 QUALITY ASSURANCE

- A. Communications and Electronics Subcontractor Quality Assurance:
 - 1. Work experience of 3 years minimum with work similar to work of this Section.
 - 2. Manufacturer's authorization to perform work of this section.
- B. Supplier's Accreditation: Use only suppliers accredited by clock system manufacturer.
- C. Supplier's Maintenance Requirements:
 - 1. Ensure local supplier has adequate facility for storage of spare parts for clock system.

2.06 DELIVERY STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver material in accordance with Section 01 60 00 - Common Product Requirements.
 - 2. Deliver materials and accessories in clock system manufacturer's original packaging with identification labels intact and to suit project.
 - 3. Ensure clock system materials are not exposed to moisture during delivery.
 - 4. Replace damaged clock system materials.
- B. Storage and Handling Requirements: Store materials off ground in dry location and protected from exposure to fumes and harmful weather conditions and at temperature conditions recommended by manufacturer.
 - 1. Store in original packaging until installed.
- C. Packaging Waste Management:
 - 1. Separate and recycle waste packaging materials in accordance with Section 01 74 19 - Construction Waste Management and Disposal.
 - 2. Remove waste packaging materials from site and dispose of packaging materials at appropriate recycling facilities.
 - 3. Collect and separate for disposal, paper and plastic material in appropriate on-site storage containers for recycling in accordance with Waste Management Plan.

2.07 WARRANTY

- A. Project Warranty: Refer to Contract Conditions for project warranty provisions.
- B. Manufacturer's warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to and not intended to limit other rights Owner may have under Contract Conditions. Whether or not covered under manufacturer's standard warranty, coverage shall include parts and labor.
- C. Warranty period: 2 years commencing on Date of Project Substantial Completion.

2.08 PRODUCTS

2.09 MANUFACTURER

- A. Basis of design will be Sapling Inc., 1633 Republic Rd Huntingdon Valley, PA 19006, Phone: 1-215-322-6063, URL: www.sapling-inc.com. Bogen is an approved manufacturer as well.
- B. Substitutions will be considered only if submitted at least 10 days prior to bid for consideration and possible approval.

2.10 SYSTEM REQUIREMENTS

- A. Ensure clock system components are designed to operate as a wireless clock system and as part of complete system including "fail-proof" design to ensure power interruption does not cause system failure.
- B. Ensure system synchronizes all clocks and devices to each other.
- C. Ensure system does not require FCC licensing.
- D. Ensure system uses frequency-hopping technology.
- E. Ensure system is capable of correcting clocks immediately upon receipt of wireless signal.
 - 1. Analog and digital clocks automatically correct themselves on receipt of wireless signal.
 - 2. Include built-in closed-loop system in analog clocks capable of allowing clocks to detect position of hands and bring clocks to correct time even if clocks are manually altered.
 - 3. Ensure analog clocks have diagnostic function capable of allowing user to view how long since clock received wireless signal.
 - 4. Ensure analog clocks are capable of functional tests of electronics and gears.
- F. Ensure each individual product is bench tested at manufacturer's facility.
 - 1. Random testing is unacceptable.
- G. Ensure each product is designed, assembled and tested in the United States of America.
- H. Basis of Design: Sapling Inc., Wireless Clock System.

2.11 MASTER CLOCK

- A. Master Clock Type 1: To UL and cUL 863.
 - 1. Ensure master clock includes 10 pre-programmed (S)NTP backup addresses.
 - 2. Ensure master clock is capable of receiving (S)NTP time signal via Ethernet.
 - 3. Ensure master clock is capable of receiving digital signals through RS485 connection.
- B. Ensure master clock is capable of correcting secondary clocks for Daylight Saving Time
 - 1. Ensure master clock is capable of customizing Daylight Saving Time, in the event of international use or a change in government regulations.
- C. Ensure master clock is capable of outputting RS485 signals.
 - 1. Ensure master clock has two clock circuits capable of outputting signals including:
- D. 59 minute correction;
- E. 58 minute correction;
- F. National Time or Rauland correction;
- G. Once a day pulse;
- H. Rauland digital correction.
 - 1. Communications Interface: Ensure master clock system is capable of being programmed remotely through online interface accessible through LAN and compatible with Microsoft Internet Explorer and Mozilla Firefox web browsers.
- I. Ensure interface includes functions as follows:
- J. Allow users to schedule bells and other events;

- K. Display features;
- L. Show IP settings;
- M. Show other master clock settings;
- N. Set time and date;
- O. Download or upload master clock settings;
- P. Configure e-mail alerts for various instances.
 - 1. Display: Two row, 20 character LED and backlit LED display and 2 x 8 inch rubber keypad for operator programming.
 - 2. Optional relays: Include 4 relays to ensure master clock is capable of utilizing 4 zones that can be used for scheduling facility systems as follows:
 - a. Bells if needed
 - 3. Lights if needed
- Q. Allow for programming of master clock through 16 button rubber tactile keypad or built-in web interface.
- R. Ensure master clock can contain up to 800 events.
- S. Ensure master clock can contain up to 255 schedule changes.
- T. Clock System: Wireless with transmitter to FCC, Part 15.
 - 1. Transmitter: Capable of transmitting data to SAL wireless analog and SBL wireless digital clocks, and receiving signal from (S)NTP time server
 - 2. Automatic bi-annual Daylight Savings Time changes.
- U. Countdown for Digital Clocks: Ensure master clock is capable of having digital clocks counting down time between events.
- V. Power Requirements: 110 V AC, 60Hz
 - 1. Ensure master clock is capable of 10 years battery power backup in event of power failure.
- W. Basis of design: Sapling Inc., SMA 3000 Series Master Clock.

2.12 REPEATERS

- A. Wireless Repeater: Capable of wirelessly transmitting and receiving data and compliant with FCC, Part 15.
 - 1. Input voltage: 85 - 230 V AC;
 - 2. Input: RS485. Sapling Wireless Communications;
 - 3. Input source: Master clock or Secondary Sapling Wireless Clock;
 - 4. RF power output: 30 dBm (1 Watt);
 - 5. Operation frequency range: 915-928 MHz frequency hopping technology;
 - 6. Mounting: Wall mount;
 - 7. Housing: 11 x 8 x 17 inches black smooth surface metal enclosure.
 - 8. Basis for design: Sapling Inc., Wireless Repeater.
- B. Network Repeater: Capable of receiving time signal through TCP/IP from master clock and compliant with FCC, Part 15.
 - 1. Input voltage: 85 - 230 V AC;
 - 2. Input: RJ45;
 - 3. Input source: Master clock;
 - 4. RF power output: 30 dBm (1 Watt);
 - 5. Frequency range: 915-928 MHz frequency hopping technology;
 - 6. Mounting: Wall mount;
 - 7. Housing: 11 x 8 x 17 inches black smooth surface metal enclosure with 7 inch antennae.
 - 8. Basis for design: Sapling Inc., Network Repeater.

2.13 SECONDARY CLOCKS

- A. Analog Clocks: To UL and cUL 863, designed for wireless system with fully automatic plug and play capability.
 - 1. Ensure secondary clock is capable of receiving wireless signals from master clock.
 - 2. Ensure each secondary clock works as an RF signal repeater, establishing a Mesh Network.
 - 3. Clock display: 12 hour white face with black numbers custom logo.
 - 4. Ensure analog secondary clock is capable of receiving Sapling wireless signals every two (2) or four (4) hours for battery models and every minute for 24 V / 110V model.
 - 5. Materials:
 - a. Dial: Polystyrene
 - b. Case: Shallow profile, smooth surface ABS
 - c. Crystal: Shatter-proof, side-molded, polycarbonate.
 - 6. Hand tolerance:
 - a. Hour and minute hands: $\pm 1/4$ minute.
 - b. Second hand: $\pm 1/2$ minute.
 - 7. Power Requirements: Battery operated.
 - a. Batteries: 2 "D" cell batteries.
 - 1) Basis for design: Duracell Procell "D" Cell batteries.
 - b. Basis of design: Sapling Inc., SAL-4 Series Wireless Round Clock.

2.14 SOURCE QUALITY CONTROL

- A. Ensure clock system components and accessories are supplied or approved in writing by single manufacturer.

2.15 EXECUTION**2.16 INSTALLERS**

- A. Use only installers with 3 years verified minimum experience with work similar to work of this Section.
- B. Ensure all clock system components are installed by single communications and electronics subcontractor.

2.17 EXAMINATION

- A. Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for clock system installation in accordance with manufacturer's written recommendations.
 - 1. Visually inspect substrate in presence of Consultant.
 - 2. Ensure surfaces are free of snow, ice, frost, grease and other deleterious materials.
 - 3. Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.
- B. Start of clock system installation indicates installer's acceptance of substrate installation conditions.

2.18 INSTALLATION

- A. Install wireless clock system in accordance with manufacturer's written recommendations and in accordance with NFPA 70E.
- B. Integrate clock system with Owner's electrical and communications network.
- C. Install wiring in accordance with requirements of local Authority Having Jurisdiction and applicable specifications.
- D. Conceal wiring except in unfinished spaces and as approved in writing by Architect/Engineer.

- E. Install clocks only after painting and other finish work is completed in each room.
- F. Install clocks and other devices square and plumb.

2.19 FIELD QUALITY CONTROL

- A. Field Inspection: Coordinate field inspection in accordance with Section 01 40 00 - Quality Control.

2.20 SYSTEM STARTUP

- A. At completion of installation and before final acceptance, turn on equipment and ensure equipment is operating properly, and clock system devices and components are functioning.
- B. Evaluate and test each device in clock system on room-by-room basis using factory-trained technicians.
 - 1. Fix or replace devices which fail test or are functioning incorrectly.
 - 2. Submit evaluation and report showing results of room-by-room tests and overall system compliance within 3 days of testing being carried out.

2.21 CLEANING

- A. Progress Cleaning: Perform cleanup as work progresses in accordance with Section 01 74 00 - Cleaning and Waste Management.
 - 1. Leave work area clean at end of each day.
- B. Final Cleaning: Upon completion, remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning and Waste Management.
- C. Waste Management:
 - 1. Co-ordinate recycling of waste materials with 01 74 19 - Construction Waste Management and Disposal.
 - 2. Collect recyclable waste and dispose of or recycle field generated construction waste created during construction or final cleaning related to work of this Section.
 - 3. Remove recycling containers and bins from site and dispose of materials at appropriate facility.

2.22 DEMONSTRATION AND TRAINING

- A. Arrange system demonstration and training session for Owner's operation and maintenance personnel.
 - 1. Allow Owner and Consultant 10 days minimum advance notice before training session.
- B. Break down system demonstration and training session into logical segments for Owner's operations and maintenance personnel.
- C. Train Owner's maintenance personnel in procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of clock system.

2.23 SYSTEM COMMISSIONING

- A. Do clock system commissioning in accordance with Manufacturer's instructions.

2.24 PROTECTION

- A. Protect installed products and accessories from damage during construction.
- B. Repair damage to adjacent materials caused by clock system installation.

END OF SECTION

SECTION 28 10 00
ACCESS CONTROL SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Access and security management system.
- B. Access control readers.
- C. Access control cables.

1.02 RELATED SECTIONS

- A. Section 26 05 00 - Common Work Results for Electrical.

1.03 REFERENCES

- A. Electronic Industries Alliance (EIA):
 - 1. RS232C - Interface between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange.
 - 2. RS485 - Electrical Characteristics of Generators and Receivers for use in Balanced Digital Multi-Point Systems.
- B. Federal Communications Commission (FCC):
 - 1. FCC Part 15 - Radio Frequency Device.
 - 2. FCC Part 68 - Connection of Terminal Equipment to the Telephone Network.
- C. Federal Information Processing Standards (FIPS):
 - 1. Advanced Encryption Standard (AES) (FIPS 197).
 - 2. FIPS 201: Personal Identity Verification (PIV) of Federal Employees and Contractors.
- D. National Fire Protection Association (NFPA):
 - 1. NFPA70 - National Electrical Code.
- E. Homeland Security Presidential Directive 12 (HSPD-12).
- F. Underwriters Laboratories (UL):
 - 1. UL294 - Access Control System Units.
 - 2. UL1076 - Proprietary Burglar Alarm Units and Systems.

1.04 SECURITY MANAGEMENT SYSTEM DESCRIPTION

- A. Pro-Watch: The Security Management System shall function as an electronic access control system and shall integrate alarm monitoring, CCTV, digital video, ID badging and database management into a single platform. A modular and network-enabled architecture shall allow maximum versatility for tailoring secure and dependable access and alarm monitoring solutions.
- B. FIPS Certification: The system shall support FIPS 201 certification.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square representing actual product, color, and patterns.
- D. Manufacturer's Product Data: Submit manufacturer's data sheets indicating systems and components proposed for use.

- E. Shop Drawings: Submit complete shop drawings indicating system components, wiring diagrams and load calculations.
- F. Record Drawings: During construction maintain record drawings indicating location of equipment and wiring. Submit an electronic version of record drawings for the Security Management System not later than Substantial Completion of the project.
- G. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, customized to the Security Management System installed. Include system and operator manuals.
- H. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a two year period for Owner's review.

1.06 QUALITY ASSURANCE

- A. Manufacturer: Minimum ten years experience in manufacturing and maintaining Security Management Systems. Manufacturer shall be Microsoft Silver Certified.
- B. Installer must be certified by Honeywell Integrated Security Dealer Service Certification Program (DSCP).

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

1.08 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.09 WARRANTY

- A. Manufacturer's Warranty: Submit manufacturer's standard warranty for the security management system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: Honeywell Security and Fire, which is located at: 2700 Blankenbaker Pkwy. Suite 150; Louisville, KY 40299; Toll Free Tel: 800-323-4576; Email:request.info@hissales@honeywell.com; Web:www.security.honeywell.com
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.02 ACCESS AND SECURITY MANAGEMENT SYSTEM (PRO-WATCH)

- A. Security Management System Manufacturer: Pro-Watch Security Management Suite as manufactured by the Honeywell Security Group.
- B. The Security Management System shall function as an electronic access control system and shall integrate alarm monitoring, CCTV, digital and network video, ID badging and database management into a single platform. A modular and network-enabled architecture shall allow maximum versatility for tailoring secure and dependable access and alarm monitoring solutions.
- C. Access Control Software Suite: The Security Management System shall offer a security management software suite available in four scalable versions: The Security Management System platform shall offer a complete access control solution: alarm monitoring, video imaging, ID badging and video surveillance control. Provide the following software system:
 1. Pro-Watch Corporate Edition: The Security Management System shall operate in the Windows Server 2012 (64-bit) and Windows Server 2012 R2 (64-bit) environment and utilize SQL Server 2012 SP1 (32-bit and 64-bit) as the database engine.

D. Software Requirements: The Security Management System shall be a modular and network-enabled access control system. The Security Management System shall be capable of controlling multiple remote sites, alarm monitoring, video imaging, ID badging, paging, digital video and CCTV switching and control that allows for easy expansion or modification of inputs and remote control stations. The Security Management System control at a central computer location shall be under the control of a single software program and shall provide full integration of all components. It shall be alterable at any time depending upon facility requirements. Security Management System reconfiguration shall be accomplished online through system programming. The Security Management System shall include the following:

1. Multi-User/Network Capabilities: The Security Management System shall support multiple operator workstations via local area network/wide area network (LAN/WAN). The communications between the workstations and the server computer shall utilize the TCP/IP standard over industry standard IEEE 802.3 (Ethernet). The communications between the server and workstations shall be supervised, and shall automatically generate alarm messages when the server is unable to communicate with a workstation. The operators on the network server shall have the capability to log on to workstations and remotely configure devices for the workstation. Standard operator permission levels shall be enforced, with full operator audit.
2. Concurrent Licensing: The Security Management System shall support concurrent client workstation licensing. The Security Management System application shall be installed on any number of client workstations, and shall provide the ability for any of the client workstations to connect to the database server as long as the maximum number of concurrent connections purchased has not been exceeded.
3. Security Key: The Security Management System shall only require a software security key to be present on the application server for the Security Management System to operate. Security keys shall not be required at the client workstations. The Security Management System shall allow a user to read the information that is programmed on the server security key. The Security Management System shall support the installation, update, and termination of the security key.
4. Terminal Services: The Security Management System shall support Windows Server 2008 Terminal Services. Terminal Services shall allow the Security Management System server application to reside on the Windows Terminal Server. Operating systems supporting a standard web browser shall be capable of utilizing the thin client architecture. The Security Management System shall support unlimited connections, based on concurrent licensing, to the Security Management System software. Full functionality shall be obtained through the intranet connection allowing full administration and monitoring without the need for a local installation.
5. Relational Database Management System: The Security Management System shall support industry standard relational database management systems. This shall include relational database management system Microsoft SQL Server 2012 SP1.
6. Database Partitioning: The Security Management System shall provide the option to restrict access to sensitive information by user ID.
7. Memory: Proprietary software programs and control logic information used to coordinate and drive system hardware shall be stored in read-only memory.
8. LDAP/ Microsoft Active Directory Services: The Security Management System shall provide support of Lightweight Directory Access Protocol (LDAP) for enabling the user to locate organizations, individuals, and other resources such as files and devices in a network, whether on the public internet or on a private intranet. The Security Management System shall provide a direct link to Microsoft Active Directory Services. The Security Management System shall allow the transfer of Active Directory users into the database via the Data Transfer Utility. Conversely, Security Management System users shall be capable of being exported to the Active Directory.

9. Unicode: The Security Management System shall utilize Unicode worldwide character set standard. The Security Management System shall support double-byte character sets to facilitate adaptation of the Security Management System user interface and documentation to new international markets. Language support shall include at a minimum English, Spanish, Portuguese, French, German and Simple Chinese.
10. Encryption: The Security Management System shall provide multiple levels of data encryption
 - a. True 128-bit AES data encryption between the host and intelligent controllers. The encryption shall ensure data integrity that is compliant with the requirements of FIPS-197 and SCIF environments. Master keys shall be downloaded to the intelligent controller, which shall then be authenticated through the Security Management System based on a successful match.
 - b. Transparent database encryption, including log files and backups
 - c. SQL secure connections via SSL
11. Supervised Alarm Points: Both supervised and non-supervised alarm point monitoring shall be provided. Upon recognition of an alarm, the system shall be capable of switching CCTV cameras that are associated with the alarm point.
12. Compliance and Validation: The Security Management System shall incorporate signature authentication where modifications to Security Management System resources will require either a single or dual signature authentication. Administrators will have the ability to select specified devices in the Security Management System where data manipulation will be audited and signatures will be required to account for the data modification. Upon resource modification, the user will be required to enter a reason for change or select a predefined reason from a list. All data will be securely stored and maintained in the database and can be viewed using the reporting tool. This functionality will meet the general requirements of Validation and Compliance through Digital Signatures with special attention to the case of Title 21 CFR Part 11 Part B compliance.
13. Clean Room Solution:
 - a. Overview: The Security Management System shall provide a clean room solution which enables users to manage their "Clean Environments" or other areas requiring special restricted access through a process-oriented graphical user interface (GUI).
 - b. Configuration: The user shall have the capability of adding, editing, or deleting clean rooms. Each "clean room" shall be capable of having a contamination level set. Entry to a higher level contamination area shall automatically restrict access to cleaner level areas. Individual cards shall be capable of being reset on an immediate one time, automatic, or per-hour basis.

E. Security Management System Operational Requirements:

1. System Operations:
 - a. Windows Authentication Login: The Security Management System shall use an integrated login method which accepts the user ID of the person who has logged on to Windows.
 - b. Password: The Security Management System shall use an integrated authentication method which utilizes Windows user accounts and policies.
 - c. Information Access: The Security Management System shall be capable of limiting operator access to sensitive information. Operators shall have proper authorization to edit the information.
 - d. Shadow Login: The Security Management System shall allow users to login over a currently logged-on user without having the current user log off the Security Management System or out of the Windows operating system.
 - e. Graphical User Interface: The Security Management System shall be fully compliant with Microsoft graphical user interface standards, with the look and feel of the

software being that of a standard Windows application, including hardware tree-based system configuration.

- f. Guard Tour: The Security Management System shall include a guard tour module, which shall allow the users to program guard tours for their facility. The tours shall not require the need for independent or dedicated readers.
- g. Secure Mode Verification (e.g., force guard to do a visual verify): The Security Management System shall provide 'secure mode' control from the verification viewer. This shall allow a user or guard to decide the access of an individual who presents his/her card at a designated secure mode reader.
- h. Database Partitioning: The Security Management System shall support dynamic partitioning. A Security Management System in which partitions are set up at installation and cannot be easily changed shall not be acceptable.
- i. Status Groups: The Security Management System shall support a real-time system status monitor that graphically depicts all logical devices.
- j. Keyboard Accelerators: The Security Management System shall allow the user to use a shortcut key to enable designated system commands.
- k. Automatically Disable Card upon Lack of Use: The Security Management System shall allow system operators to set a predefined time period in which cardholders shall swipe their card through a card reader in the Security Management System.
- l. User Functions and ADA Ability: The Security Management System shall provide user functions and ADA (Americans with Disabilities Act) ability that provides the capability to trigger an event at the Security Management System intelligent controller when a defined card is presented.
- m. Pathways: The Security Management System shall support the capability of programming pathways. A pathway shall be an object that combines input points to be masked (shunted) for a set duration, and an output point to be activated, when a particular card receives a local grant at a reader.
- n. Database Audit Log: The Security Management System shall be capable of creating an audit log in the history file following any change made to the Security Management System database by an operator.
- o. Operator Log: The Security Management System shall be capable of creating an action log in the history file following actions performed by an operator.
- p. Alarm Routing: The Security Management System shall be capable of defining routing groups that determine what event information shall be routed to a user or class of users.
- q. Global and Nested Anti-passback: The Security Management System shall support the use of an optional anti-passback mode, in which cardholders are required to follow a proper in/out sequence within the assigned area.
- r. Two Person Rule: The Security Management System shall support a "two person rule" to restrict access to specific access areas unless two cardholders present two different valid cards to the reader one after the other within a period time defined by the door unlock time multiplied by a factor of 2.
- s. Occupancy Restrictions: The Security Management System shall allow the user to define the minimum and maximum occupancy allowed in a designated area.
- t. Multiple Sequential Card Swipes to Initiate Procedure: The Security Management System shall allow the user to define a logical device, quantity of consecutive identical events, a time period and a Security Management System procedure to trigger when the event occurs a maximum quantity of times in the allocated time period.
- u. Hardware Templates: The Security Management System shall include the ability to define hardware templates (door templates) in order to simplify the process of creating an access control system. Hardware templates shall allow a user to define a

"typical" door configuration and then use that template over and over in the process of defining doors.

- v. MRDT. Pro-Watch can accommodate Mercury Intrusion hardware like the Mercury MRDT ("Mercury Digital Terminal") with keypad. MRDT works with PW-6000 panel to provide intrusion functionality. Mercury Intrusion requires a special Pro-Watch license.
- 2. Access Control Functional Requirements: Functions shall include validation based on time of day, day of week, holiday scheduling, site code verification, automatic or manual retrieval of cardholder photographs, and access validation based on positive verification of card/PIN, card, and video. The following features shall be programmable and shall be capable of being modified by a user with the proper authorization:
 - a. Time Zones: Shall define the period during which a reader, card, alarm point, door, or other system feature is active or inactive. In addition to Monday-Sunday, there shall be at least one day of the week called Holiday.
 - b. Holidays: The application shall allow holidays to be entered into the Security Management System. Holidays shall have a start date plus duration defining multiple days. Holidays shall have a holiday type of 1, 2, or 3, which may be defined by the user.
 - c. Response Codes: The Security Management System shall allow the user to enter a predefined code to represent a response to an alarm occurring in the facility.
 - d. Clearance Codes: The Security Management System shall allow the user to establish groups of readers at a facility for the purpose of granting or denying access to badge holders. Clearance codes shall be assigned to companies and individuals employed by the company, and may be modified for individual users in the badge holder maintenance application.
 - e. Companies: Each badge holder entered into the Security Management System shall be assigned a company code identifying the individual's employer. The company information dialog box displays and maintains information related to companies having access to the facility.
 - f. Group Access: The Security Management System shall allow a user or group of users via company selection, a temporary denial of access to specific readers or areas based on a preconfigured event. The group access function shall limit access to a group of cardholders, overriding all other access criteria.
 - g. Event: Definitions shall be shipped with system software but shall be capable, upon installation, of being modified, added to, or deleted from the Security Management System.
 - h. Alarm Pages: Security Management System shall include the capability to create an unlimited number of customized alarm pages for the alarm monitor and each shall be assignable to users and user classes.
 - i. Event Types: Definitions shall be shipped with system software but shall be capable, upon installation, of being modified, added to, or deleted from the Security Management System.
 - j. Dynamic Graphical Maps: The Security Management System shall provide the user with the means to add maps and indicator icons to maps that shall represent input/output points, logical devices, or cameras located throughout the Security Management System. Security Management System maps shall display the state and condition of alarm points. The Security Management System shall also provide the ability to monitor the channels or panels.
 - k. Brass Keys: Shall maintain information related to assets that are issued in the facility, including brass keys, laptops, RSA keys, cell phones, company cards, etc.
 - l. ID Badging Client: The Security Management System Shall maintain information related to a badge holder's card access privileges. Upon entering this application, a window shall appear on the screen and all actions (add, modify, or delete) involving badges and cards shall be initiated from this window. Access privileges shall be linked

to the cards used to gain access to doors in the facility. Modifications shall be made by adding or deleting clearance codes, or by door types assigned to the cards or to a badge holder.

- m. ID Badging System: The Security Management System shall include seamlessly integrated ID badging system.
- n. Users: Information related to the users of the Security Management System software shall be stored in the database. Users entered into the Security Management System shall be assigned the access privileges of the class to which they are assigned.
- o. Elevator Control: The elevator control shall be of the Security Management System intelligent controller-based line of devices. The elevator control shall include the following functional features:
 - 1) Elevator call: Valid card read calls elevator to the floor. No reader in the elevator car.
 - 2) Floor control: Valid card read in the elevator car enables selectable floor buttons.
 - 3) Floor select: Valid card read in the elevator car enables selectable floor buttons and logs which floor is selected after the card is presented.
- p. Data Transfer Unit (DTU): The DTU enables data to be imported from an external system directly into the Security Management System database and also exported from Pro-Watch to an external system.
 - 1) Insert only: If a "data file key column #" shall be provided, the DTU will only insert a new badge record if the key column value is not found. An error shall be displayed in the log file if an existing badge record is found. If no "data file key column #" is provided, every record will be inserted into the Security Management System.
 - 2) Updates only: The DTU shall use the "data file key column #" to look for the matching Security Management System record. An error shall be logged in the log file if the badge holder is not found in the Security Management System database.
 - 3) Inserts, updates: The DTU shall use the "data file key column #" to look for the matching Security Management System record. If a matching record is not found, the DTU shall insert the data. If a matching record is found, the record shall be updated.
 - 4) DTU shall support SOAP web services.
- q. Generic Channel Interface: The Security Management System shall provide the ability to define generic communications channels over serial port or TCP/IP network socket including IP address and port/socket, to support custom integration of external foreign devices. The Security Management System shall generate events based on data received from the channel matching operator pre-defined instructions.

3. Application Localization: The Security Management System shall support at least seven languages including English. The languages available shall include German, French, Spanish, Italian, Chinese (simplified), Portuguese (Brazil), Norwegian, Chinese (Traditional), Danish, and Dutch. All database resources will be localized, and will include a standard U.S. English help file.
4. Event Manager: The Security Management System shall utilize an event manager as a component of system administration and offer the ability to have users control the amount of data stored as well as a quick snapshot of the logged data in the system. Using the various logs in event manager, the user will be able to gather information about events, auditing, and operator actions. The logs are defined as follows: Event log, audit log, unacknowledged alarms.

F. Intelligent Controllers - Hardware Requirements:

1. Distributed architecture shall allow controllers to operate independently of the host. The architecture shall place key access decisions, event/action processing and alarm monitoring functions within the controllers, eliminating degraded mode operation.
2. Flash memory management shall support firmware updates and revisions to be downloaded to the system. Upgrades to the hardware and software shall occur seamlessly without the loss of database, configurations, or historical report data.
3. Manufacturers: Subject to compliance with requirements, provide Field Controllers or comparable product by one of the following:
 - a. Honeywell Security Star II (Legacy support only)
 - b. Honeywell Security PW-2000
 - c. Honeywell Security PW-3000 (Legacy support only)
 - d. Honeywell Security PW-5000
 - e. Honeywell Security PW-6000
 - f. Honeywell Security PW-6101ICE
4. Cardkey Controllers: The Security Management System software suite shall provide functionality to Cardkey Controllers using Nodal Protocol B, the Cardkey Controllers D620 (Firmware revision PS-143D or PS143-E), and the Cardkey D600AP (Firmware Revisions PS-155A or PS-155B). Supported interface is currently, but not limited to, standard STI and STIE devices. Minimum functionality to be supported:
 - a. Controller to host communications.
 - b. Downloading of cards.
 - c. Downloading of Security Management System parameters.
 - d. Downloading of reader parameters.
 - e. Downloading of input point parameters.
 - f. Downloading of relay output point parameters.

G. Field Hardware:

1. The security management system shall be equipped with access control field hardware required to receive alarms and administer all access granted/denied decisions. All field hardware shall meet UL requirements.
 - a. Intelligent Controller Board:
 - 1) Honeywell Security PW6K1IC
 - b. Dual Reader Module (DRM):
 - 1) Honeywell Security PW6K1R2
 - c. SALTO Locksets:
 - 1) Locksets compatible with SVN - Salto's Virtual Network.
 - d. Card Readers:
 - 1) Wireless Readers:
 - (a) ASSA ABLOY APERIO Wireless Reader.
 - (b) SCHLAGE Wireless Reader.

H. Digital Video Recording Systems:

1. The Security Management System shall provide fully integrated support for a powerful network and digital video recording and transmission system. The Security Management System shall record, search and transmit video, and shall provide users with live, pre- and post- event assessment capabilities. The NVRs/DVRs shall be seamlessly integrated with existing video equipment and incorporated into any TCP/IP network. The NVRs/DVRs shall provide multiple levels of integration with the Security Management System software, providing control of the network or digital video system from the access control application.
2. Manufacturer and part numbers:
 - a. Honeywell MAXPRO® VMS
 - b. Honeywell Fusion III series digital recorders
 - c. Honeywell Rapid Eye Multi-Media series digital recorders

- d. Integral Technologies DVXi series digital recorders
- e. Integral Technologies DSXpress Series digital recorders

I. Video Management Systems (VMS):

- 1. With integration to VMS, Security Management System shall control multiple sources of video subsystems in a facility to collect, manage and present video in a clear and concise manner. VMS intelligently determines the capabilities of each subsystem across various sites, allowing video management of any analog or digital video device through a unified configuration and viewer. Disparate video systems are normalized and funneled through a common video experience. Drag and drop cameras from the Security Management System hardware tree into VMS views. Leverage Security Management System alarm integration and advanced features such as pursuit that help the operator track a target through a set of sequential cameras with a single click to select a new central camera and surrounding camera views.
- 2. Manufacturer and part numbers:
 - a. Honeywell Security MAXPRO VMS.

J. Intercom Interface:

- 1. The interface shall provide control of both remote and master intercom stations from within the Security Management System application. The Security Management System shall allow the user to define the site, channel, description, and address as well as provide a checkbox for primary station.
- 2. Administrators shall have the capability to program a list of intercom functions that report to the alarm-monitoring module as events. These functions shall coincide with the intercom functions provided with the intercom system. For each intercom function, Security Management System administrators shall be able to define an alphanumeric event description 1 to 40 characters in length and shall also be able to set the parameter value of that function.
- 3. The intercom interface shall allow for secondary annunciation of intercom calls, events, and alarms in the alarm-monitoring window. Intercom reporting to the alarm monitoring window shall report as any other access control alarm and shall have the same annunciation and display properties as access control alarms.
- 4. All intercom calls, events, and alarms that report into the Security Management System shall be stored in the system database for future audit trail and reporting capabilities. Intercom events shall include but not be limited to: Station busy, Station free, Intercom call to busy station, Intercom call to private station, Station disconnected, Function dialed outside connection, Intelligent station ID, Station reset, Station lamp test, Audio program changed, Group hunt occurred, Mail message, Digit dialed during connection, Direct access key pressed, Handset off hook, M-key pressed, C-key pressed
- 5. Manufacturer(s) and part numbers:
 - a. Stentofon/Zenitel Alphacom series intercoms.
 - b. Command series intercoms.

K. Intrusion Detection Panels:

- 1. Honeywell VISTA-128FBP, VISTA-128BPE, VISTA-128BPT, VISTA-250FBP, VISTA-250BPE, and VISTA-250BPT Controllers:
 - a. General Requirements: The Security Management System shall support hardwired and TCP/IP communication for the VISTA 128FBP/VISTA-250 FBP panel. Each panel shall have 8 partitions and 15 zone lists. Zones, partitions, and the top-level panel shall have an events page, with all supported events present. Features:
 - 1) Disarm and unlock a door on card swipe.
 - 2) Arm and lock a door on card swipe.
 - 3) Common area arm/disarm.
 - 4) Access denied if intrusion system is in alarm or armed.

- 5) Monitor and log intrusion system events and alarms in the Security Management System.
- 6) Associate intrusion system events and alarms to video surveillance integrations.
2. Honeywell Galaxy Dimension GD264 and GD520 Controllers:
 - a. Security Management System users are able to control and monitor group and zone status using the Security Management System client, and control the individual zones and groups using Security Management System Access control credentials. Depending on the combined user profiles and access permissions defined in Security Management System, a Security Management System cardholder is allowed or denied permission to arm/disarm zones and groups. The access control functionality of the intrusion panel is disabled when the integration is operational. Features:
 - 1) Disarm a zone on a card swipe.
 - 2) Arm a zone on consecutive card swipes. Security Management System will support definition of quantity of swipes required and the timeout time in seconds to recognize consecutive swipes.
 - 3) Security Management System supports linking of intrusion panel users with Security Management System cardholders.
 - 4) Security Management System operators may be given control permissions for intrusion input and output alarms.
 - 5) Security Management System can associate alarm events with video commands to look at current or historic footage.
 - 6) Security Management System stores and reports on intrusion events.
- L. Software Development Kit (SDK)
 1. Security Management System shall permit custom integration with other third party systems through an SDK. SDK shall support the OBIX communication protocol and interface directly with the Niagara Framework for support of additional communications protocols.
 2. Manufacturer and part numbers:
 - a. Honeywell Security HSDK.
- M. Visitor Management System
 1. The Visitor Management System shall allow the user to track visitors, employees, assets and deliveries as they enter and exit the facilities.
 2. The system shall also support printing of custom designed visitor passes with details like expiration date, visit area, host being visited, and visit purpose.
 3. Manufacturer and part numbers:
 - a. Honeywell Security LobbyWorks.
- N. Web Client:
 1. Web Alarms
 2. Web Events
 3. Web Badging
 4. Web Reports
- O. Supported Web Browsers:
 1. (Windows) Internet Explorer 11
 2. (Windows) Google Chrome Version 42

2.03 ACCESS CONTROL READERS

- A. Contactless Smart Card Readers:
 1. Contactless Smart Card readers shall be "single-package" type, combining electronics and antenna in one package in the following configurations:

2. Provide surface mounting style 13.56 MHz or 13.56 MHz and 125 kHz prox contactless smart card readers suitable for minimal space mounting configurations as shown on the project plans.
3. Contactless smart card readers shall comply with ISO 15693, ISO 14443A (CSN), and ISO 14443B and shall read credentials that comply with these standards.
4. Contactless smart card readers shall output credential data in compliance with the SIA AC-01 Wiegand standard as follows:
 - a. Reads standard proximity format data from OmniClass cards and outputs data as encoded.
 - b. Reads card serial number (CSN) of a MIFARE or DESFIRE card with configurable outputs as 26-bit, 32-bit, 34-bit, 40-bit, or 56-bit.
5. Data security with OmniClass cards shall use up to 128-bit authentication keys to reduce the risk of compromised data or duplicate cards. The contactless smart card reader and OmniClass cards shall require matching keys in order to function together. All RF data transmission between the card and the reader shall be encrypted, using a secure algorithm. Card readers shall be provided with keys that are compatible with the OmniClass cards.
6. The reader shall be of potted, polycarbonate material, sealed to a NEMA rating of 4X (IP65).
7. The contactless smart card reader shall provide the ability to change operational features in the field through the use of a factory-programmed command card. Additionally, firmware may be updated by flashing the reader. Command card operational programming options shall include:
 - a. Output configurations.
 - b. LED & Audio configurations.
 - c. Keypad configurations.
8. Contactless smart card readers shall provide the following programmable audio/visual indication:
 - a. An audio transducer shall provide various tone sequences to signify: access granted, access denied, power up, and diagnostics.
 - b. A high-intensity light bar shall provide clear visual status (red/green/amber) that is visible even in bright sunlight.
9. Contactless smart card readers shall meet the following certifications:
 - a. UL 294.
 - b. Canada/UL 294.
 - c. FCC Certification.
 - d. Canada Radio Certification.
 - e. EU and CB Scheme Electrical Safety.
 - f. EU - R&TTE Directive.
 - g. CE Mark (Europe).
 - h. IP55 Rated.
 - i. C-Tick (New Zealand/Australia/Taiwan).
10. Contactless smart card readers shall meet the following environmental specifications:
 - a. Operating temperature: -30 to 150 degrees F (-35 to 65 degrees C).
 - b. Operating humidity: 5% to 95% relative humidity non-condensing.
 - c. Weatherized design suitable to withstand harsh environments.
11. Contactless smart card reader cabling requirements shall be:
 - a. Manufacturer: Honeywell Cable
 - b. Cable distance: (Wiegand): 500 feet (150m).
 - c. Cable type: 6-conductor #22 AWG minimum with overall foil shield and drain wire
 - d. Standard reader termination: 18 inches (.5m) cable pigtail.

12. Warranty of contactless smart card readers shall be lifetime against defects in materials and workmanship.
- B. Product: OM31 Mini-Mullion 13.56 MHz Contactless Smart and 125 kHz Prox Card Readers as manufactured by the Honeywell Security Group:
 1. Typical contactless smart card read range shall be:
 - a. 2 inches - 3 inches (5.0 - 7.6 cm) using OmniClass card.
 - b. 1 inches (2.5 cm) using OmniClass Key Fob.
 - c. 1 inches(2.5 cm) using OmniClass Sticker (Tag).
 - d. 1 inches - 1.5 inches (2.5 - 3.8 cm) using OmniClass + HID 125KHz Prox card.
 - e. 1 inches - 2 inches (2.5 - 5.0 cm) using MIFARE Card (card serial number only).
 - f. 1 inches - 3.5 inches (2.5 - 8.9 cm) using 125 kHz Prox Card
 2. Contactless smart card readers shall meet the following electrical specifications:
 - a. Operating voltage: 5 - 16 VDC, reverse voltage protected. Linear power supply recommended.
 - b. Current requirements: (average/peak) 75/100mA @ 12 VDC.
 3. Contactless smart card readers shall meet the following physical specifications:
 - a. Dimensions: 1.90 inches x 4.04 inches x .80 inches (4.83cm x 10.26 cm x 2.03 cm).
 - b. Weight: 3.2.oz (90.7 g).
 - c. Material: UL94 Polycarbonate.
 - d. Two-part design with separate mounting plate and reader body.
 - e. Color: Black.
- C. Product: OM41 US Single-Gang 13.56 MHz Contactless Smart and 125 kHz Prox Card Readers as manufactured by the Honeywell Security Group:
 1. Typical contactless smart card read range shall be:
 - a. 2.5 inches - 4.5 inches (6.3 - 11.4 cm) using OmniClass card.
 - b. 1 inches (2.5 cm) using OmniClass Key Fob.
 - c. 1 inches (2.5 cm) using OmniClass Sticker (Tag).
 - d. 1.5 inches - 2 inches (3.8 - 5.0 cm) using OmniClass + 125KHz HID Prox card.
 - e. 1 inches - 2 inches (2.5 - 5.0 cm) using MIFARE Card (card serial number only).
 - f. 1 inches - 3.5 inches (2.5 - 8.9 cm) using 125 kHz Prox Card
 2. Contactless smart card readers shall meet the following physical specifications:
 - a. Dimensions: 3.30 inches x 4.80 inches x .85 inches (8.38 cm x 12.19 cm x 2.16 cm).
 - b. Weight: 8.8 oz (249.5 g).
 - c. Material: UL94 Polycarbonate.
 - d. Two-part design with separate mounting plate and reader body.
 - e. Color: Black.
 3. Contactless smart card readers shall meet the following electrical specifications:
 - a. Operating voltage: 5 - 16 VDC, reverse voltage protected. Linear power supply recommended.
 - b. Current requirements: (average/peak) 85/100mA @ 12 VDC.

2.04 ACCESS CONTROL CABLES

- A. Access Control System components shall be connected using the following Honeywell Genesis Series Cables:
 1. Shielded 6-Conductor Reader Cables: foil shielded with drain wire, stranded copper conductors:
 - a. 18AWG:
 - 1) General Purpose Rated: CM, CL2, Sunlight Resistant Listed: Part #: 1216.
 - 2) Riser Rated: CMR, CL2R, FT4, Sunlight Resistant Listed: Part #: 2216.
 - 3) Plenum Rated: CMP, CL2P, FT6 Listed: Part #: 3216.
 2. Bundled Access Control Cables: 4 components, Overall jacketed bundle.

- a. Part #: 3196, Plenum Rated, CMP, CL2P, FT6 Listed.
 - 1) Component 1: 22 AWG, 6 stranded conductors, shielded.
 - 2) Component 2: 18 AWG, 4 stranded conductors.
 - 3) Component 3: 22 AWG, 2 stranded conductors.
 - 4) Component 4: 22 AWG, 4 stranded conductors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine site conditions to determine site conditions are acceptable without qualifications. Notify Owner in writing if deficiencies are found. Starting work is evidence that site conditions are acceptable.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. System, including but not limited to access control, alarm monitoring and reporting, time management, and user identification cards shall be installed in accordance with the manufacturer's installation instructions.
- B. Supervise installation to appraise ongoing progress of other trades and contracts, make allowances for all ongoing work, and coordinate the requirements of the installation of the System.

3.04 FIELD TESTING AND CERTIFICATION

- A. Testing: The control, alarm monitoring and reporting, time management, and user identification cards shall be tested in accordance with the following:
 1. Conduct a complete inspection and test of all installed access control and security monitoring equipment. This includes testing and verifying connection to equipment of other divisions such as life safety and elevators.
 2. Provide staff to test all devices and all operational features of the System for witness by the Owner's representative and authorities having jurisdiction as applicable.
 3. Correct deficiencies until satisfactory results are obtained.
 4. Submit written copies of test results.

3.05 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 28 16 01
INTRUSION DETECTION SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Burglary/access control/CCTV intrusion detection system.
- B. Intrusion detection cables.

1.02 RELATED SECTIONS

- A. Section 26 05 00 - Common Work Results for Electrical.

1.03 REFERENCES

- A. Reference Standards: Provide systems which meet or exceed the requirements of the following publications and organizations as applicable to the Work of this Section:
 - 1. Underwriters Laboratories Inc. (UL):
 - a. UL 365: Police Station Connected Burglar Alarm Units and Systems.
 - b. UL 636: Holdup Alarm Units and Systems.
 - c. UL 684: Local, Central Station, and Remote Station.
 - d. UL 985: Household Fire-Warning System Units
 - e. UL 1037: Antitheft Alarms and Devices
 - f. UL 1610: Central-Station Burglar-Alarm Units.
 - g. UL 1635: Installation and Classification of Residential Burglar Alarm Systems.
 - 2. Federal Communications Commission (FCC):
 - a. Code of Federal Regulations Title 47: Part 15: Radio Frequency Devices.
 - b. Code of Federal Regulations Title 47: Part 68: Connection of Terminal Equipment to the Telephone Network.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Manufacturer's Product Data: Submit manufacturer's data sheets indicating systems and components proposed for use, including instruction manuals.
- C. Shop Drawings: Submit complete shop drawings including connection diagrams for interfacing equipment, list of connected equipment, and locations for major equipment components.
- D. Record Drawings: During construction maintain record drawings indicating location of equipment and wiring. Submit an electronic version of record drawings not later than Substantial Completion of the project.
- E. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, customized to the system installed. Include system and operator manuals.
- F. Field Tests: Submit results of field testing of every device including date, testing personnel, retesting date if applicable, and confirmation that every device passed field testing.
- G. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a one year period for Owner's review. Maintenance shall include, but not be limited to, labor and materials to repair the system, provide test and adjustments, and regular inspections.
- H. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, represent actual product, color, and patterns.

1.05 QUALITY ASSURANCE

- A. Manufacturer: Minimum ten years of experience in manufacturing and maintaining similar systems. Alarm manufacturer shall be certified compliant with ISO 9001.

- B. Installer: Minimum two years of experience installing similar systems, and acceptable to the manufacturer.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish areas designated by Architect.
 - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
 - 3. Refinish mock-up area as required to produce acceptable work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's labeled packages. Store and handle in accordance with manufacturer's requirements, in a facility with environmental conditions within recommended limits.
- B. Store products in manufacturer's unopened packaging until ready for installation.

1.07 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: Honeywell Security and Fire. Toll Free Tel: 800-323-4576; Email: hissales@honeywell.com; Web: www.security.honeywell.com.
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.02 INTRUSION DETECTION CONTROL PANELS

- A. Basis-of-design shall be the Honeywell VISTA 128BPT System, a burglary/access control/CCTV switching system that includes the following capabilities:
 - 1. Listed for UL Commercial Burglary.
 - 2. Compatible Detection Devices: Addressable.
 - 3. Addressable Inputs: 120.
 - 4. Access Readers: 8.
 - 5. Onboard Communication: Digital Dialer.
 - 6. Onboard Inputs: 9.
 - 7. Communication Choices: Digital Dialer, TCP/IP, GSM.
 - 8. Event Log: 512.
 - 9. Supports up to 128 zones.
 - 10. Supports up to 8 separate partitions.
 - 11. Supports up to 150 users.
 - 12. Supports commercial wireless devices.
 - 13. Wireless Inputs: 127.
 - 14. Provides integrated security, access control, and CCTV switching capability.
 - 15. Provides supervision of peripheral devices.
 - 16. Supports up to 96 relay outputs.
 - 17. Supports long-range radio (LRR) communication.
 - 18. Provides scheduling capability to allow for automated operations.
 - 19. Supports alarm reporting via Internet.
 - 20. Interfaces with automation software.
 - 21. Monitors smoke detector maintenance signals.

22. Capable of being installed using existing wiring.

B. Environmental Conditions: System shall be designed to function in the following environmental conditions:

1. Storage Temperature: Designed for a storage temperature of -10 degree C to 70 degree C.
2. Operating Temperature: System shall be designed for an operating temperature of 0 degree C to 50 degree C (32 degree F to 120 degree F).
3. Humidity: System shall be designed for normal operation in an 85% relative humidity environment.
4. Electromagnetic Interference: System shall meet or exceed the requirements of FCC Part 15, Class B devices, FCC Part 68, IEC EMC directive.

C. Power Requirements: Components shall have the following electrical specifications. The system shall operate using standard 120 VAC, 50 Hz/60 Hz power.

1. Control Primary Power: Transformer power shall be 16.5 VAC, 40 VA.
2. Backup Battery: Rechargeable 12 VDC, gel type, lead acid backup battery shall be provided. The battery shall be rated between 12 and 34-ampere hours (AH).
3. Alarm Power: 12 VDC, 1.7 amps for each bell output
4. Auxiliary Standby Power: 12 VDC, 0.75 amp maximum.
5. Total Power: Combined auxiliary standby and alarm currents shall be 2.3 amps.
6. Fusing: The battery input, auxiliary, and bell outputs shall be protected using PTC circuit breakers. All outputs shall be power limited.

D. Control Panel Enclosure: A metal cabinet, suitable for wall mounting. Dimensions shall not exceed 14.5 inches (36.8 cm) in height, 12.5 inches (31.8 cm) in width or 3 inches (7.6 cm) in depth.

E. Control Panel: The control panel shall be an 8-partition, UL commercial and burglary control panel that supports zones using basic hardwired, polling loop, and wireless zones, RF receivers, and relay modules. The control shall provide the ability to schedule time-driven events, and allow certain operations to be automated by pressing a single button. The system shall be capable of interfacing with an ECP long range radio (LRR) unit that can send Contact ID messages. The control shall provide integrated access control and CCTV-switching capability with the use of a single downloader and database.

1. Basic Hardwired Zones: Control shall provide 8 style-B hardwire zones with the following characteristics:
 - a. EOLR supervision (if required for zones 2-8) shall support N.O. or N.C. sensors (EOLR supervision required for UL installations).
 - b. Zones/Points shall be individually assignable to any partition.
 - c. Supports up to 16 two-wire smoke detectors on zone 1.
 - d. Supports four-wire smoke or heat detectors on any zone (power to four-wire smoke detectors must be supervised with an EOL device).
2. Expansion Zones:
 - a. Polling Loop Expansion: Control shall support up to 120 additional hardwire zones using a built-in two-wire polling (multiplex) loop interface. The polling loop shall provide power and data to remote point modules, and constantly monitor the status of all zones on the loop. Maximum current draw shall not exceed 128 mA. The polling loop zones shall have the following characteristics:
 - 1) Interface with RPM (Remote Point Module) devices that provide Class B, Style Y (e.g., 4208U/4208SN) or a combination of Class B, Style Y, and Class A, Style Z (e.g., 4208SNF) zones.
 - 2) Individually assignable to one of 8 partitions.
 - 3) Supervised by the control panel.
 - 4) A 12,000 feet (3658 m) wire runs capability without using shielded cable.

- 5) Each RPM (Remote Point Module) enclosure shall be tamper protected.
- b. Wireless Expansion Zone: Control shall support wireless zones using a 5800 series RF receiver (fewer if using hardwire and/or polling loop zones). Wireless zones shall have the following characteristics:
 - 1) Supervised by control panel for check-in signals (except certain non-supervised transmitters).
 - 2) Tamper-protection for supervised zones.
 - 3) Individually assignable to one of 8 partitions.
 - 4) Individually assignable to bell outputs and/or auxiliary relays.
 - 5) Support wireless devices listed for Commercial Burglary using the 5881ENHC RF Receiver.
3. Partitions: Control shall provide the ability to operate e8 separate areas, each functioning as if it had its own control. Partitioning features shall include:
 - a. A Common Lobby partition (1-8), which can be programmed to perform the following functions:
 - 1) Arm automatically when the last partition that shares the common lobby is armed.
 - 2) Disarm when the first partition that shares the common lobby is disarmed.
 - b. A Master partition (9), used strictly to assign keypads for the purpose of viewing the status of all 8 partitions at the same time (master keypads).
 - c. Assignable by zone.
 - d. Assignable by keypad/annunciator.
 - e. Assignable by relay to one or all 8 partitions.
 - f. Ability to display burglary and panic and/or trouble conditions at all other partitions' keypads (as a selectable choice).
 - g. Certain system features selectable by partition, such as entry/exit delay and subscriber account number.
4. User Codes: Control shall accommodate user codes, all of which can operate any or all partitions. Certain characteristics must be assigned to each user code, as follows:
 - a. Authority level (Master, Manager, or several other Operator levels). Each User Code (other than the installer code) shall be capable of being assigned the same or a different level of authority for each partition that it will operate.
 - b. Specific partitions that the code can operate.
 - c. Global arming capability (ability to arm all partitions the code has access to in one command).
 - d. Use of an RF (button) to arm and disarm the system (RF key must first be enrolled into the system).
5. Peripheral Devices: Control shall support up to 30 addressable ECP devices, which can be any combination of keypads, RF receivers, relay modules, and interactive phone module. Peripheral devices have the following characteristics:
 - a. Each device set to an individual address according to the device's instructions.
 - b. Each device enabled in system programming.
 - c. Each device's address shall be supervisable (via programming).
6. Keypad/Annunciator: Control shall accommodate up to 16 keypads or six (6) touch-screen (i.e.; advanced user interface) keypads. The keypads shall be capable of the following
 - a. Performing all system arming functions.
 - b. Being assigned to any partition.
 - c. Providing four programmable single-button function keys, which can be used for:
 - 1) Panic Functions: activated by wired and wireless keypads; reported separately by partition.
 - 2) Keypad Macros: 32 keypad macro commands per system (each macro is a series of keypad commands). Assignable to the A, B, C, and D keys by partition.

7. Output Relays: A total of 96 relay outputs shall be accommodated using relay modules. Each relay module shall provide four (4) Form C (normally open and normally closed) relays for general-purpose use. The relays shall be capable of being:
 - a. Programmed to activate in response to system events.
 - b. Programmed to activate using time intervals.
 - c. Activated manually.
 - d. Assigned an alpha descriptor.
 - e. A combination of 4204 (ECP) and 4101SN (polling loop) relays.
8. Integrated Access Control: Control shall be capable of the following:
 - a. Providing a command that activates relays to allow access doors to open (e.g., lobby door), lights to be turned on or off, etc.
 - b. Becoming a fully integrated access control system by using numerous VistaKey Single-Door Access Control Modules.
 - c. Supporting up to 15 VistaKey Access Control Modules. The VistaKey Access Control Modules shall use the same Compass Downloader as the Vista-250BPT and shall be programmable from the Compass Downloader or the Keypad/Annunciators.
 - d. Assigning any number of access control relays to each partition (up to 96 for the system).
 - e. Supporting up to 500 access card holders using VistaKey.
9. Commercial Wireless Equipment: Control shall be compatible with UL Listed Commercial Wireless Security equipment including:
 - a. ADEMCO 5881ENHC Commercial Wireless Receiver: The receiver shall be capable of receiving as many points as the control panel is rated for. Up to two (2) Receivers may be used on any system. Receivers may be remotely located anywhere on the system Keypad/Annunciator bus.
 - b. Honeywell 5808W3 Wireless Photoelectric Smoke and Heat Detector: The device shall be UL 268 listed and shall have Maintenance Alert capability and Automatic Drift Compensation.
 - c. ADEMCO 5809 Wireless 135D Fixed Temperature and Rate of Rise Heat Detector: The device shall be UL 521 listed for commercial applications.
 - d. ADEMCO 5817CB Wireless Universal Contact Monitoring Transmitter: This device shall be capable of making any conventional UL listed contact device a wireless device. The device shall be UL listed for commercial burglary applications as follows: UL 365, 609, 1023, 1076 and 1610 for security and nurse call.
 - e. ADEMCO 5869 Wireless Hold Up Switch/Transmitter: This device shall be UL 636 listed for commercial burglary applications.
10. Keypad: Control shall support the ADEMCO 4146 Keypad on any one of the system's 8 partitions. If used, zone 7 is no longer available as a protection zone.
11. Voltage Triggers: System shall provide voltage triggers, which change state for different conditions. Used with devices such as a remote keypad sounder or keypad ARMED and READY LEDs.
12. Event Log: System shall maintain a log of different event types (enabled in programming). The event log shall provide the following characteristics:
 - a. Stories events.
 - b. Viewable at the keypad or through the use of Compass software.
 - c. Printable on a serial printer, including zone alpha descriptors.
13. Scheduling: Provides the following scheduling capabilities:
 - a. Open/close schedules (for control of arming/disarming and reporting).
 - b. Holiday schedules (allows different time windows for open/close schedules).
 - c. Timed events (for activation of relays, auto-bypassing and un-bypassing, auto-arming and disarming, etc.).
 - d. Access schedules (for limiting system access to users by time).

- e. End User Output Programming Mode (provides 20 timers for relay control).
- f. The system shall automatically adjust for daylight savings time.
- 14. Communication Features: Supports the following formats and features for the primary and secondary central station receivers:
 - a. Formats: ADEMCO Express; ADEMCO Contact ID 4 and 10 Digit Acct number.
 - b. Backup reporting: The system shall support backup reporting via the following: Secondary phone number; ECP long-range radio (LRR) interface; with ability to select long range radio (LRR) or dialup as the primary reporting method (dynamic signaling feature).
 - c. Internet reporting: The system shall be capable of communicating with the central station via the internet using Alarmnet-i. It shall provide the user with the ability to control the system via a browser interface (i.e., AOL, Netscape, Internet Explorer). All packet data transmitted to the monitoring station shall be encrypted with a minimum of 1024 bits of encryption.
- 15. Cross-Zoning Capability: Helps prevent false alarms by preventing a zone from going into alarm unless its cross-zone is also faulted within 5 minutes.
 - a. Alarm notification appliances, including but not limited to sirens horns, bells and strobes.
 - b. Auxiliary devices capable of operating using full-wave rectified unfiltered voltage.
- 16. Exit Error False Alarm Prevention Feature: System shall be capable of differentiating between an actual alarm and an alarm caused by leaving an entry/exit door open. If not subsequently disarmed, the control panel shall:
 - a. Bypass the faulted E/E zone(s) and/or interior zones and arm the system.
 - b. Generate an Exit Error report by user and by zone so the central station knows it was an exit alarm and who caused it.
- 17. Built-in User's Manual and Descriptor Review: For end-user convenience, the control panel shall contain a built-in User's Manual. It shall include the following capabilities:
 - a. By depressing any of the function keys on the keypad for five (5) seconds, a brief explanation of that function shall scroll across the alphanumeric display.
 - b. By depressing the READY key for five (5) seconds, all programmed zone descriptors shall be displayed (one at a time). This feature shall provide a check for installers and ensure all descriptors have been entered properly.
- 18. Programming: Control shall be capable of being programmed locally or remotely using the ADEMCO Compass Downloader and shall be capable of:
 - a. Uploading and downloading all programming information at 300 baud.
 - b. Uploading and displaying firmware revision levels from the control.
- 19. Automation Software: The Control shall be capable of interfacing with automation software via an RS232 input on a single partition.

F. Communications Options

- 1. GSM/GPRS reporting - The system shall be capable of communicating with the central station by way of wireless GSM/GPRS using Alarmnet-GSM/GPRS service. The installer shall furnish a Honeywell model GSMV4G or equivalent. It shall provide the user with the ability to control the system via a browser interface (i.e. Internet Explorer). All packet data transmitted to the monitoring station shall be encrypted.

G. User Interfaces

- 1. Keypad, Alpha Display: The system keypad shall include a two-line, alphanumeric LCD display. Use the Honeywell Vista 6160 keypad or equivalent. The installer shall follow manufacturer's installation instructions when installing system equipment.

H. VPLEX Addressable Detection Devices. System shall integrate with facility doors, windows, and departments. The system shall also integrate with external systems, such as building appliances and building alert systems for remote control and central collection of external

system alerts. When integrated with external systems, the system shall connect to the external system to receive status changes by way of a dry contact output from the external system. The system shall use its user interface to provide local status messages from external systems, providing for the initiation of local building policies. The system may transmit information to an off-site monitoring service to provide initiation of remote policies when appropriate. The installer shall follow manufacturer's instructions when installing and programming system equipment.

1. VPLEX Bus Extensions: Extended system VPLEX bus branch circuits shall be scale able to increase the total size of the bus in larger installations. Branch circuits leading from different buildings or from different floors in multi-story buildings shall be isolated from one another so that a shorted or grounded branch circuit is isolated away from other near-side branch circuits, allowing other VPLEX devices to be isolated so that they can continue to operate. The installer shall furnish Honeywell Model 4297 VPLEX Bus Extender modules for each 128 mA of current required on the VPLEX bus.
2. VSI Bus Isolation and Integrity: System VPLEX bus branch circuits shall be isolated from one another so that a shorted, overloaded, or grounded branch circuit is isolated away from other near-side branch circuits, allowing undamaged VPLEX bus circuits to continue to operate. VSI Isolation modules shall be installed at near-side connections to cable runs leading to additional buildings, at cable runs leading to additional floors in multi-story buildings, and at junction boxes leading to multiple VPLEX branch circuits within the system. The installer shall use the Honeywell VSI module or equivalent.
3. Individual Zone Input: When zone inputs shall be located next to individual detection devices, system zone inputs allow the system to sense the change in state of an output from an external device, such as a door/window position sensor, a motion detector, a relay output from an appliance, the output of an external alert system, or other devices that provide a dry closure output. The installer shall furnish Honeywell Model 4193SN zone input modules for each detection device that will be connected to the VPLEX Bus.
4. Filled Metal Doors and Windows, Exposed, VPLEX: Monitor the opened and closed position of doors and windows in the facility. The installer shall install a Honeywell Model 4939SN Exposed Addressable Sensor, or equivalent. The installer shall follow manufacturer instructions while installing and programming system equipment.
5. Filled Steel Frame Doors, VPLEX, Exposed, Armored: Monitor the opened and closed position of doors in the facility. The installer shall install a Honeywell Model 960 Door sensor, and a 4193SN or equivalent. The installer shall follow manufacturer instructions while installing and programming system equipment.
6. Roof Hatch Doors, Exposed, VPLEX: Monitor the opened and closed position of doors in the facility. The installer shall install a Honeywell Model 4939SN Exposed Addressable Sensor, or equivalent. The installer shall follow manufacturer instructions while installing and programming system equipment.
7. Overhead Doors: Monitor the opened and closed position of overhead bay doors in the facility. The installer shall install a Honeywell Model 4959SN Overhead Door sensor, or equivalent. The installer shall follow manufacturer instructions while installing and programming system equipment.
8. Dual-Tec Motion Detector, Wall-Mounted, VPLEX: Selected areas in the protected site will use motion detectors to sense motion in rooms or areas of rooms. Where designated in the plans, install a Honeywell Model DT7500SN VPLEX Dual-Tec Motion Detector or equivalent.
9. Panic Buttons: Include manual panic buttons under desks, in storage rooms, in walk-in refrigeration units and other designated locations. The panic button shall be the Honeywell Model 269SN or equivalent.

I. SPECIAL APPLICATIONS

1. Automatic Door Locking: Selected doors in the facility will use system automatic door locking capabilities to restrict entry to into the facility, yet allow free exit by those who have

completed their business. For each automatic locking door, install a 4101SN relay output module, a power supply, and an electric locking device.

2. Kitchen Alert Systems: The system shall provide sensing of critical conditions within the kitchen or food processing facility. The system shall alert the user when the temperature is too high, when the humidity is too high, when air conditioning condensation drip pans require draining and when there is an extended power failure.
- J. Sirens, Sounders and Indicators
 1. Siren, Outdoor, High Output in Enclosure: Monitor the status of protected openings and areas in the armed and disarmed state. When an audible alarm occurs, the system shall sound a Honeywell Model 702 Siren or equivalent inside of the Model 743BE Enclosure. The installer shall install the siren as directed by manufacturer instructions.

2.03 INTRUSION DETECTION CABLES

- A. Intrusion Detection System components shall be connected using the following Honeywell Genesis Series Cables:
 1. Keypads use four conductor, 18AWG with 22AWG, non-shielded cable:
 - a. Element 1: 18AWG:
 - 1) General Purpose applications: Part #: 1119.
 - 2) Riser applications: Part #: 2115.
 - 3) Plenum applications: Part #: 3115.
 - b. Element 2: 22AWG:
 - 1) General Purpose applications: Part #: 1104.
 - 2) Riser applications: Part #: 2104.
 - 3) Plenum applications: Part #: 3104.
 2. VPLEX Zone Expanders shall connect to a VPLEX data bus using two conductor, 18AWG, non-shielded cable.
 - a. General Purpose applications: Part #: 1118.
 - b. Riser applications: Part #: 2114.
 - c. Plenum applications: Part #: 3114.
 - d. Direct burial applications: Part #: 4156.
 3. VPLEX Fire detection devices and two wire fire detection devices connect using two conductor, 18AWG, non-shielded fire alarm cable.
 - a. General Purpose applications: Part #: 4106.
 - b. Riser applications: Part #: 4306.
 - c. Plenum applications: Part #: 4506.
 - d. Direct burial applications: Part #: 4156.
 4. Four wire fire detection devices connect using four conductor, 18AWG, non-shielded fire alarm cable.
 - a. General Purpose applications: Part #: 4107.
 - b. Riser applications: Part #: 4307.
 - c. Plenum applications: Part #: 4507.
 - d. Direct burial applications: Part #: 4157.
 5. Unpowered detection devices connect to zone inputs using two conductor, 22AWG, non-shielded cable.
 - a. General Purpose applications: Part #: 1102.
 - b. Riser applications: Part #: 2102.
 - c. Plenum applications: Part #: 3102.
 6. Powered detection devices connect to zone inputs using four conductor, 18AWG, non-shielded cable.
 - a. General Purpose applications: Part #: 1119.
 - b. Riser applications: Part #: 2115.
 - c. Plenum applications: Part #: 3115.

- d. Direct burial applications: Part #: 4157.
7. The Bell output shall use two conductor, 16AWG, non-shielded cable.
 - a. General Purpose applications: Part #: 1125.
 - b. Riser applications: Part #: 2121.
 - c. Plenum applications: Part #: 3121.
8. Power connections for control panels shall be made using two conductor, 16AWG, non-shielded cable.
 - a. General Purpose applications: Part #: 1125.
 - b. Riser applications: Part #: 2121.
 - c. Plenum applications: Part #: 3121.
9. Ground connections to control panels shall be made using 14AWG solid insulated copper ground wire.
 - a. General Purpose applications: Part #: 1131.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine site conditions prior to installation. Notify Architect and Owner in writing if unsuitable conditions are encountered. Do not start installation until site conditions are acceptable.

3.02 INSTALLATION

- A. Intrusion detection and fire alarm control panel system shall be installed and tested in accordance with manufacturer's installation instructions.
 1. Coordinate interfaces with Owner's representative where appropriate.
 2. Provide backboxes, pullboxes, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.
 3. Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent fill in conduits. Gather wires and tie to create an orderly installation.
 4. Coordinate with other trades to provide proper sequencing of installation.

3.03 FIELD COMMISSIONING AND CERTIFICATION

- A. Field Commissioning: Test system as recommended by manufacturer, including the following:
 1. Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.
 2. Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction as applicable.
 3. Correct deficiencies until satisfactory results are obtained.
 4. Submit written copies of test results.

3.04 TRAINING

- A. Conduct on-site system training, with the number of sessions and length of sessions as recommended by the manufacturer. Training shall include administration, provisioning, configuration, operation and diagnostics.

3.05 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 28 23 19
NETWORK VIDEO RECORDING SYSTEM

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Provide a complete IP video recording system, including engineering, components, installation and commissioning.

1.02 RELATED SECTIONS

- A. Not used

1.03 REFERENCES

- A. Reference Standards: Provide systems which meet or exceed the requirements of the following publications and organizations as applicable to the Work of this Section:
 1. Canadian ICES-003
 2. Consultative Committee for International Radio (CCIR)
 3. Conformity for Europe (CE)
 4. Electronic Industry Association (EIA)
 5. Federal Communications Commission (FCC)
 6. Joint Photographic Experts Group (JPEG)
 7. Moving Pictures Experts Group (MPEG)
 8. Motion Joint Photographic Experts Group (MJPEG)
 9. National Television Systems Committee (NTSC)
 10. Phase Alternating by Line (PAL)
 11. Underwriters Laboratories Inc. (UL)
 12. Institute for Electrical and Electronics Engineers (IEEE)
 13. ITU-T Video Coding Experts Group (VCEG)
 14. Physical Security Interoperability Alliance (PSIA)
 15. Open Network Video Interface Forum (ONVIF)
 16. Real Time Streaming Protocol (RTSP)

1.04 DEFINITIONS

- A. HD (High-definition) - refers to video having resolution substantially higher than traditional television systems. HD has one or two million pixels per frame.
- B. CIF (Common Intermediate Format) - refers to a standard video format, which is categorized based on the resolution.

1.05 SYSTEM DESCRIPTION

- A. The Network Video Recorder (NVR) supports simultaneous recording, remote viewing and search, and system management for up to 64 IP cameras including high definition formats. Multiple NVRs may be deployed for system expansion using a distributed architecture and integrated with the multi-site software or enterprise video management system.
- B. Basis-of-design is the Honeywell MAXPRO NVR PE.

1.06 SUBMITTALS

- A. Manufacturer's Product Data: Submit manufacturer's data sheets indicating systems and components proposed for use, including instruction manuals.
- B. Shop Drawings: Submit complete shop drawings including connection diagrams for interfacing equipment, list of connected equipment, and locations for major equipment components.
- C. Record Drawings: During construction maintain record drawings indicating location of equipment and wiring. Submit an electronic version of record drawings not later than Substantial Completion of the project.

- D. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, customized to the system installed. Include system and operator manuals.
- E. Field Tests: Submit results of field testing of every device including date, testing personnel, retesting date if applicable, and confirmation that every device passed field testing.
- F. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a one year period for Owner's review. Maintenance shall include, but not be limited to; labor and materials to repair the system, provide test and adjustments, and regular inspections.

1.07 QUALITY ASSURANCE

- A. Manufacturer: Minimum ten years experience in manufacturing and maintaining IP video recording systems. Manufacturer shall provide toll-free technical assistance and support available 24/7.
- B. Manufacturing Location: Provide equipment assembled in the United States.
- C. Installer: Minimum ten years experience installing similar systems, and acceptable to the manufacturer of the IP video recording system - and must be located within 30 miles of the project location. Integrator must employ a minimum of 5 manufacturer trained technicians on the specified product.
- D. Environmental Conditions: The NVR shall be designed to function in the following environmental conditions:
 1. Operating Temperature: 32°F to 95°F (0°C to 35°C).
 2. Emissions: FCC part 15B Class A; EN 55022 Class A
 3. Immunity: EN 50130-4
 4. Safety: ANSI / UL 60950-1; CAN / CSA C22.2 No. 60950-1; IEC 60950-1.
 5. RoHS: EN 50581
- E. Power Requirements: NVR shall have the following electrical specifications:
 1. Input Voltage: 110/220 VAC 50/60 Hz
 2. Operating Voltage: 110V/220V Auto Sensing
 3. Power Dissipation:
 - a. Average BTU rating = 880 BTU/HR
 - b. Peak BTU rating = 2800 BTU/HR

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's labeled packages. Store and handle in accordance with manufacturer's requirements, in a facility with environmental conditions within recommended limits.

1.09 WARRANTY

- A. Manufacturer's Warranty: The warranty period shall be thirty six (36) months from the date of project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Network Video Recording System (NVR) Manufacturer: Honeywell MAXPRO NVR PE Network Video Recording System, www.honeywell.com/security.
- B. Accepted Alternates: Refer to substitution procedures in section 01 60 00. Substitution requests will only be accepted for review prior to bid. After bids are submitted, substitutions will not be permitted.

2.02 SYSTEM COMPONENTS

- A. NVR Server: The NVR Server shall contain the recording engine, database of all network-connected cameras and encoders, integrated components and their configurations. Server shall be provided as a combined hardware and software device.
- B. Workstation Software (NVR Client): The NVR Client software shall render video and act as a main human/machine interface.

2.03 OPERATIONAL REQUIREMENTS

- A. NVR shall provide a user-friendly graphical user interface (GUI) to configure the cameras, create schedules for recording, perform video surveillance and recording operations, and view various reports.
- B. NVR shall be configured to store and to view images captured by 64 cameras.
- C. NVR shall have following major capabilities:
 1. Record and monitor up to 64 IP channels at 1920 fps @ 4CIF/VGA or 1920 fps @ 720p HD or 1920 fps @ 1080p (4 Mbps bitrate) HD per MAXPRO NVR PE. Network bandwidth/throughput supported per NVR with Incoming: 256 Mbps, Outgoing: 425 Mbps providing a Total: 681 Mbps. Archival support of 25 channels @ 4 Mbps bitrate each (100 Mbps total archival throughput capacity per MAXPRO NVR PE), with outgoing archival storage throughput of 275 Mbps. Multi-stream support with maximum 128 streams per MAXPRO NVR PE. Support for configuring one (1) preferred stream for continuous recording and one (1) preferred stream for live video/motion based recording per camera. Support for One-Way Audio (for specific IP cameras) with live, playback and clip export on NVR desktop client for up to 64 IP channels.
 2. Live viewing of up to 64 IP cameras on a single remote workstation with up to two (2) monitors set up at CIF resolution. For 4CIF and HD resolution, the number of live streams needs to be benchmarked based on client hardware configuration deployed. Cost-effective enhanced HD video rendering on remote desktop clients with support for monitoring of up to 23 1080p HD cameras in real time (30 fps)/690 fps 1080p HD with no-time lapse using the GPU capabilities of in-built processor graphics with 6th generation Intel® Core™ Processors for client systems. Up to 4 1080p HD @ 30 fps/120 fps on local client.
 3. Powerful investigation and video archive search tools from remote client.
 4. Native device integrations supporting equiP® Series cameras' new features: 4K resolution, H.265 video compression codec, 3D PTZ control, 360° camera support, and intelligence events.
 5. Capable of managing motion detection-based recording with pre-event and post-event recording based on camera based motion detection or Server based motion detection events (SMART VMD) and "advanced" search on recordings from remote client.
 6. Preview and Calendar Search permitting search for videos and events based on user-selected date and time from remote client. SMART motion search - fast and efficient forensic search and investigation for objects/motion on recorded video using Honeywell SMART motion detection Analytics algorithms on the client PC without impacting the NVR Server load.
 7. Simultaneous use of multiple video compressions including MJPEG, MPEG-4, H.265 and H.264.
 8. Internationalization - supports the following languages: French, German, Russian, Italian, Spanish, Dutch, Arabic and English.
 9. Email on alarm.
 10. Instant clip creation from snapshot.
 11. Dynamic IP Camera Discovery - Automatically discover all compatible cameras connected to NVR.
 12. Multi-level user access rights for viewing and manages access to the recorder functions.

13. Capable of managing continuous, scheduled, manual, event-based, and alarm-based recording features.
14. Advanced security features with encryption support for communication between desktop client to NVR and secure https login for Web Client and mobile apps.
15. Support for web client and mobile apps.

D. Mode for User Login: NVR shall have the option of two modes of user logins:

1. Windows Authentication: Uses Windows logged-in user name.
2. User DB Authentication: Uses preconfigured user name and password.

E. Workstation (NVR Client) shall provide the following operator options:

1. Configuration: The operator (with Administrator privileges) shall have the option to configure the NVR. Live update of all configurations is supported. The following configurations shall be possible:
 - a. System Configuration: Provide options to configure the system level settings.
 - b. Camera Configuration: Provide options to add/edit/delete IP cameras and encoders.
 - c. Schedules: Provide options to configure schedule based recording for cameras connected to the NVR.
 - d. Input and Output: Provide options to configure camera input and output.
 - e. Sequences: Provide options to group a fixed number of cameras to view video.
 - f. User Management (Users and Roles): Provide option to add/edit/delete users.
 - g. Clip Deletion Settings: Provide the ability to automatically utilize more storage on event-initiated recording.
 - h. Independent deletion setting for continuous recording.
 - i. Independent deletion setting for event recording.
 - j. Surrounding Cameras: Provide option to grant a user the ability to view a single camera surrounded by the cameras programmed as the "Surrounding Cameras".
 - k. 3D Positioning: The user shall be able to view a specific object in the live video in a 3-dimensional view. This feature is available in the Context menu options and is only supported with New equiP PTZs HDZ302DE, HDZ302D, and HDZ302DIN. 3D positioning options include: Click-based camera positioning, Rectangle selection 3D positioning, and Restore to last PTZ position.
 - l. Profile Cameras: Multi-zoom views on HD video and support to create virtual cameras by digitally zooming into the field of view. For example: zooming in on a cash register in one view of the HD camera while at the same time monitoring the cashier in the zoomed out view of that HD camera.

F. Configurations for cameras connected to NVR:

1. Camera Configuration: The user shall be able to configure the following parameters for each camera connected to the NVR.
 - a. Camera Name
 - b. IP Address
 - c. Camera Type
 - d. Fixed/PTZ
 - e. Continuous Recording: All cameras added shall be defaulted to "24/7" recording with the option to select other recording modes.
 - f. Event Based Recording: Shall be "None" by default, with the option to select motion-based recording.
 - g. User name: Shall display and enable setting the user name for a camera.
 - h. Password: Shall enable setting the password for a camera.
 - i. Camera Advanced Settings: Shall enable configuration of Video Format, Compression Format, Resolution, Compression, Video Frame Rate, GOP, Record Quality Settings, Clip Deletion Settings, Launching Web View of camera for Advanced Setup, Motion detection zones configuration for Server based motion detection, Video

Archival Settings, Multi-Stream Settings and Video Preview. Shall enable configuration of RTSP URL for cameras or encoders added with camera type - Generic RTSP.

2. The following video recording options shall be supported:
 - a. Scheduled based recording: The system shall support the ability to schedule recordings for each individual camera for times in the future. By default, the NVR shall be pre-loaded with the following four schedules: 24x7, Weekday, Daytime, and Nighttime, which cannot be edited. A maximum of 50 schedules can be created in the NVR.
 - b. User based recording: The user shall be able to configure user activated settings for recording moments of interest while viewing live video from a camera. After configuring the user activated settings, the operator can start recording of video when needed. The video is recorded for the time period specified in the System settings for user activated recording. The User based Recording Time Duration shall be selectable from a list of values ranging between 30 seconds and 5 minutes.
 - c. Event based recording: Event based recording shall be possible on SMART Video Motion Detection and alarm triggers. The NVR must be capable of managing motion detection-based recording with pre-event and post event recording based on camera and Server-based motion detection events. The server-based SMART VMD analytics must be object-based and not traditional pixel-based, reducing false alarms due to changing light conditions, video noise, rain or other false alarm triggers that occur using pixel-based (traditional) VMD.
- G. Viewer: The NVR Viewer shall have the following minimum capabilities:
 1. Main video viewing screen capable of showing 1, 4, 9, 16, and other customized split salvos of live or recorded video. Standard presets shall be customizable to the user preferences.
 2. Capable of saving current salvo as a View and allowing the user to drag this view at any later point in time.
 3. Capable of configuring and running scan sequences.
 4. Capable of adjusting the contrast, brightness, and saturation settings for each camera independently.
 5. Capable of exporting user selected image or video clips in simple .wmv, .ASF, .MPVC and .BMP formats. Capable of attaching a digital signature for authentication of exported clips in .wmv format.
 6. Capability to play back the video clips exported. Each video channel that is being recorded by the recording system shall be overlaid with text and a time stamp that is customizable by the user.
 7. MAXPRO Video Container (.MPVC) format support - only playable in MAXPRO desktop clients and standalone Clip Player. Features quicker exports of raw video and support for estimating clip size and split to multiple clips to ensure clip storage media matches. Include the clip player with exported clip for easier review of video evidence and efficient investigation. Clip Player - Portable standard secure player for archived and exported clips (*.MPVC), 360 camera de-warping and 2x2 Salvo support. Smooth playback support with up to 256x review speed. No software needed to run on a Windows PC, with the option to include the clip player with the exported clip.
 8. Allow the user to initiate recording through the GUI or a controller.
 9. Capability of complete alarm management for the alarms coming from the NVR.
 10. Facility of surrounding camera view.
 11. Option to perform various operations through context menu on a particular video (live/recorded/sequence). These operations include: Full screen, point and drag, maintain aspect ratio, toggle text, digital PTZ, add bookmark, start recording, stop recording, mark in, mark out, save image, save image as, show surrounding cameras.

12. Ability to manage timeline control of the recording device, which provides camera recording statistics. Timeline control shall have the following features: Mark input (with looping facility), bookmark, snapshot, time slider, time jump, play controls.
13. Preference configuration including: frame rate of unselected panels, rendered type, preview pane, text display format.

H. Search: The Search facility shall include search for recorded video and events based on date and time.

I. Reports: The Report facility shall include event history report and audit log report.

2.04 NVR INTEGRATIONS

- A. NVR shall be compatible with the following interoperability standards:
 1. Physical Security Interoperability Alliance (PSIA)
 2. Open Network Video Interface Forum Profile S (ONVIF Profile S)
 3. Real Time Streaming Protocol (RTSP)
- B. NVR shall be compatible with the following Fixed and PTZ IP cameras
 1. Honeywell Performance Series, equiP® Series and New equiP® Series IP cameras
 2. Supports IP cameras from the following manufacturers. Please contact Honeywell for the complete list of manufacturers and models.
 - a. AXIS® Communications
 - b. Sony
 - c. Panasonic
 - d. Bosch
 - e. Samsung
 - f. Vivotek
 - g. Pelco
- C. NVR shall be compatible with the following encoders:
 1. Honeywell HVE Series Encoders
 2. Supports Encoders from the following manufacturers. Please contact Honeywell for the complete list of manufacturers and models.
 - a. AXIS® Communications
 - b. Sony
 - c. Panasonic
 - d. Bosch
 - e. Samsung
 - f. Vivotek
- D. NVR shall be compatible with the following 360° Camera solutions. Please contact Honeywell for the complete list of models.
 1. Honeywell equiP® Series Fisheye IP Cameras: HFD6GR1
 2. Oncam Grandeye
 3. Immervision Enables® - Panomorph Lenses
 4. AXIS® 360°/180°
 5. Arecont 360°/180°
- E. NVR shall be compatible with the following Video Management Systems:
 1. Honeywell MAXPRO® VMS
- F. NVR shall be compatible with the following Access Control Security System:
 1. Honeywell Pro-Watch® Access Control System through MAXPRO® VMS and MAXPRO® Viewer
- G. Video Analytics supported through MAXPRO® VMS:
 1. Honeywell Active Alert

2.05 SYSTEM HARDWARE

- A. NVR Server: MAXPRO NVR PE Server - NVR Server shall operate with no performance degradation using the following minimum hardware and operating system configuration:
 - 1. 2U 8 bay storage unit with SAS hard drives
 - 2. Processor: Intel® Core™ i7-4790, 3.6 GHz, Intel® HD Graphics 4600
 - 3. Memory: 8 GB
 - 4. Power supply: Dual redundant 820 W
 - 5. OS Drives: 2 x 2.5" 128 GB SATA solid state drives, RAID 1 support
 - 6. Operating system: Windows Embedded Standard 7, 64-bit SP1
 - 7. Database: Microsoft SQL Server Express 2008 R2
 - 8. Storage capacities: 4 TB to 48 TB raw storage, Video storage redundancy with RAID 5/6 support
 - 9. Video Storage Hard Disk Options: 8 field-upgradable 1 TB, 2 TB, 3 TB, 4 TB or 6 TB SAS Hard Disk Drive options
 - 10. Optical drive: DVD-RW
 - 11. Network interface: Dual 1 Gigabit Ethernet
 - 12. RAID card: 6 GB SAS/SATA RAID card, PCI Express x8, supports RAID levels up to 6+0
 - 13. Human Interface: 102-key keyboard and a mouse pointing device
 - 14. Monitor Output: HDMI with DVI-D to HDMI adapter or VGA or DVI-D or Display Port (1 monitor support)
 - 15. Rack kit: Rack kit for use with 2U chassis
- B. NVR Workstation: NVR Workstation shall operate with no performance degradation using the following recommended hardware and operating system configuration for rendering up to twenty-three (23) 1080p HD cameras in real time (30 fps)/690 fps @ 1080p HD with no time-lapse. Workstation configuration assumes two-monitor setup. Workstation is required for remote clients only; a local client is available on the NVR PE unit for configuration and monitoring. The performance specifications below are recommended for systems with fixed or PTZ cameras only. Oncam Grandeye 360 cameras and H.265 cameras are not supported with GPU rendering and use CPU rendering by default. On Windows 7 workstations, GPU rendering is only supported through the motherboard monitor outputs and any additional graphics cards should be disabled in BIOS. On Windows 8.1 and Windows 10 workstations with Intel GPU and any additional graphics cards, at least one monitor should be connected to the motherboard monitor output.
 - 1. Processor: Intel® Core™ i7-6700, 3.4 GHz or equivalent 6th generation Intel® Core™ Processors for client systems.
 - 2. Graphics Adapter: In-built Processor Graphics (GPU): Intel® HD Graphics 530, 4600 or equivalent.
 - 3. System Memory (RAM): 8 GB
 - 4. Optical Drive: DVD-RW
 - 5. Hard Disk Drives: Single Disk or RAID 0 or 0+1 10K SATA 80GB or 10K to 15K
 - 6. SAS 73 GB.
 - 7. Network Interface Card (NIC): 1 Gbps
 - 8. Human Interface: 102-key keyboard and a mouse pointing device
 - 9. Operating System: Microsoft® Windows 7 Professional 64-bit SP1, Windows 8.1 Professional 64-bit, or Windows 10 Professional 64-bit.

2.06 MANUFACTURER SUPPORT

- A. Manufacturer shall provide customer service, pre-sales applications assistance, after-sales technical assistance, access to technical online support, and online training using Web conferencing.

- B. Manufacturer shall provide 24/7 technical assistance and support via a toll-free telephone number at no extra charge.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine site conditions prior to installation. Notify Architect and Owner in writing if unsuitable conditions are encountered. Do not start installation until site conditions are acceptable.

3.02 INSTALLATION

- A. Test all components before shipping to the project location.
- B. NVR system shall be installed, programmed, and tested in accordance with manufacturer's installation instructions.
 1. Coordinate interfaces with Owner's representative where appropriate.
 2. Provide backboxes, racks, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.
 3. Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent fill in conduits. Gather wires and tie to create an orderly installation.
 4. Coordinate with other trades to provide proper sequencing of installation.
 5. Provide NVR workstation where directed by Owner unless otherwise shown on drawings.
 6. Provide NVR server(s) as required and shown on drawings.

3.03 FIELD COMMISSIONING AND CERTIFICATION

- A. Field Commissioning: Testing the IP Video Recording system as recommended by manufacturer, including the following:
 1. Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.
 2. Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction as applicable.
 3. Correct deficiencies until satisfactory results are obtained.
 4. Submit written copies of test results.

3.04 TRAINING

- A. Conduct on-site system administrator and security/surveillance operator training, with the number of sessions and length of sessions as recommended by the NVR system manufacturer. Training shall include administration, provisioning, configuration, operation, and diagnostics.

END OF SECTION

SECTION 28 31 00
FIRE DETECTION AND ALARM

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Fire alarm system design and installation, including all components, wiring, and conduit.
- B. Transmitters for communication with supervising station.
- C. Circuits from protected premises to supervising station, including conduit.
- D. Replacement and removal of existing fire alarm system components, wiring, and conduit indicated.
- E. Maintenance of fire alarm system under contract for specified warranty period.

1.02 RELATED REQUIREMENTS

- A. Section 08 71 00 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.
- B. Section [] - Fire Pumps: Supervisory devices.
- C. Section 21 13 00 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.
- D. Section [] - Passenger Elevators: Elevator systems monitored and controlled by fire alarm system.
- E. Section 23 33 00 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
- B. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
- C. NFPA 70 - National Electrical Code.
- D. NFPA 72 - National Fire Alarm and Signaling Code.
- E. NFPA 101 - Life Safety Code.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Drawings must be prepared using AutoCAD Release 11_.
 - 1. Owner will provide floor plan drawings for Contractor's use; verify all dimensions on Owner-provided drawings.
- C. Evidence of designer qualifications.
- D. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 - 4. System zone boundaries and interfaces to fire safety systems.
 - 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.

6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
7. List of all devices on each signaling line circuit, with spare capacity indicated.
8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
10. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
11. Certification by the manufacturer of the control unit that the system design complies with the contract documents.
12. Certification by Contractor that the system design complies with the contract documents.

E. Evidence of installer qualifications.

F. Evidence of instructor qualifications; training lesson plan outline.

G. Evidence of maintenance contractor qualifications, if different from installer.

H. Inspection and Test Reports:

1. Submit inspection and test plan prior to closeout demonstration.
2. Submit documentation of satisfactory inspections and tests.
3. Submit NFPA 72 "Inspection and Test Form," filled out.

I. Operating and Maintenance Data: See Section 01 78 00 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:

1. Complete set of specified design documents, as approved by authority having jurisdiction.
2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
4. List of recommended spare parts, tools, and instruments for testing.
5. Replacement parts list with current prices, and source of supply.
6. Detailed troubleshooting guide and large scale input/output matrix.
7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.

J. Project Record Documents: See Section 01 78 00 for additional requirements; have one set available during closeout demonstration:

1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
2. "As installed" wiring and schematic diagrams, with final terminal identifications.
3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

K. Closeout Documents:

1. Certification by manufacturer that the system has been installed in compliance with his installation requirements, is complete, and is in satisfactory operating condition.
2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
3. Certificate of Occupancy.
4. Maintenance contract.

- L. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
 - 1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
 - 2. In addition to the items in quantities indicated in PART 2, furnish the following:
 - a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
 - b. One copy, on CD-ROM, of all software not resident in read-only-memory.

1.05 QUALITY ASSURANCE

- A. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 - 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 - 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 - 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
- C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
- C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Alarm Control Units - Basis of Design: FIRE LITE .
- B. Fire Alarm Control Units - Other Acceptable Manufacturers: Provided their products meet or exceed the performance of the basis of design product, products of the following are acceptable:
 - 1. Honeywell Security & Fire Solutions/Fire-Lite: www.firelite.com.
 - 2. Provide all control units made by the same manufacturer.
- C. Initiating Devices, and Notification Appliances:

1. Honeywell Security & Fire Solutions/Fire-Lite: www.firelite.com.
2. Same manufacturer as control units.
3. Provide all initiating devices and notification appliances made by the same manufacturer.

D. Substitutions: See Section 01 60 00 - Product Requirements.

1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with contract documents.
2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with contract documents.

2.02 FIRE ALARM SYSTEM

A. Fire Alarm System: Provide a new FIRELITE automatic fire detection and alarm system:

1. Provide all components necessary, regardless of whether shown in the contract documents or not.
2. Protected Premises: Entire building shown on drawings.
3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards for Accessible Design.
 - b. The requirements of the State Fire Marshal.
 - c. The requirements of the local authority having jurisdiction, which is State Of Delaware Fire Marshall's office.
 - d. Applicable local codes.
 - e. The contract documents (drawings and specifications).
 - f. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
7. Program notification zones and voice messages as directed by Owner.
8. Hearing Impaired Occupants: Provide visible notification devices in all public areas and in dwelling units.
9. Fire Command Center: Location indicated on drawings.
10. Master Control Unit (Panel): New, located at fire command center.

B. Supervising Stations and Fire Department Connections:

1. Public Fire Department Notification: By on-premises supervising station.
2. On-Premises Supervising Station: None.
3. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), 2 telephone lines.

C. Circuits:

1. Initiating Device Circuits (IDC): Class A, Style D.
2. Signaling Line Circuits (SLC) Within Single Building: Class A, Style 7.
3. Notification Appliance Circuits (NAC): Class A, Style Z.

D. Spare Capacity:

1. Initiating Device Circuits: Minimum 25 percent spare capacity.
2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
3. Speaker Amplifiers: Minimum 25 percent spare capacity.

4. Master Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
- E. Power Sources:
 1. Primary: Dedicated branch circuits of the facility power distribution system.
 2. Secondary: Storage batteries.
 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
 4. Each Computer System: Provide uninterruptible power supply (UPS).

2.03 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
 1. Sprinkler water control valves.
 2. Dry-pipe sprinkler system pressure.
 3. Dry-pipe sprinkler valve room low temperature.
 4. Fire pump(s).
 5. Elevator shut-down control circuits.
- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
 1. Sprinkler water flow.
 2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
 3. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
 4. Duct smoke detectors.
- C. Elevators:
 1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
 2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
 3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.
- D. HVAC:
 1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.

2.04 COMPONENTS

- A. General:
 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Fire Alarm Control Units, Initiating Devices, and Notification Appliances: Analog, addressable type; listed by Underwriters Laboratories as suitable for the purpose intended.
- C. Master Control Unit: As specified for Basis of Design above, or equivalent.
- D. Remote Announciators: Fire Lite.
- E. Initiating Devices:
 1. Manual Pull Stations: Fire Lite.
 - a. Provide 2 extra.
 2. Key Operated Pull Stations: Fire Lite.
 - a. Provide 2 extra.
 3. Smoke Detectors: Fire Lite.
 - a. Provide 2 extra.
 4. Duct Smoke Detectors: Fire Lite.
 - a. Provide 2 extra.
 5. Heat Detectors: Fire Lite.

- a. Provide 2 extra.
- 6. Addressable Interface Devices: Fire Lite.
- 7. Provide 2 extra.
- F. Notification Appliances:
 - 1. Bells: Fire Lite.
 - 2. Speakers: FireLite.
 - a. Provide 2 extra.
 - 3. Strobes: Fire Lite.
 - a. Provide 2 extra.
- G. Circuit Conductors: Copper or optical fiber; provide 400 feet extra; color code and label.
- H. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
- I. Locks and Keys: Deliver keys to Owner.
- J. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
 - 1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 - 2. Provide one for each control unit where operations are to be performed.
 - 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
 - 4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the contract documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.

3.02 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.03 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 - 1. Hands-On Instruction: On-site, using operational system.
 - 2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:

1. Initial Training: 1 session pre-closeout.
- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 1. Initial Training: 1 session pre-closeout.
- D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.04 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 1. Be prepared to conduct any of the required tests.
 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 5. Repeat demonstration until successful.
- B. Occupancy of the project will not occur prior to Substantial Completion.
- C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 1. Approved operating and maintenance data has been delivered.
 2. Spare parts, extra materials, and tools have been delivered.
 3. All aspects of operation have been demonstrated to Owner.
 4. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 5. Occupancy permit has been granted.
 6. Specified pre-closeout instruction is complete.

3.05 MAINTENANCE

- A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.
- C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
 1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
 2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
 3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- D. Provide trouble call-back service upon notification by Owner:
 1. Provide on-site response within 2 hours of notification.
 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

- F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- G. Comply with Owner's requirements for access to facility and security.

END OF SECTION

SECTION 311000 - SITE CLEARING

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. Project Site Information:

1. The Hazardous Substance Cleanup Act (HSCA) allows for Voluntary Cleanup Program (VCP).
2. DNREC and DFM have entered into a VCP Agreement at this site (DE-1559). This site has elevated levels of Arsenic in the soil based on sample evidence that was collected. For further details contact Stephen Johnson, DNREC Project Officer at 302-395-2600
3. All soils we are required to remain on site and be incorporated into the project based on the VCP agreement.
4. Owner must be notified immediately if for some reason soil would need to be removed from this parcel of land.

B. This Section includes the following:

1. Protecting existing trees, shrubs, plants and grass to remain.
2. Removing existing trees and other vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning site utilities in place and removing site utilities.
7. Temporary erosion and sedimentation control measures.

C. Related Sections include the following:

1. Division 01 Section "Temporary Construction Utilities, Facilities & Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities.
2. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
3. Division 32 Section "Turf and Grasses" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

1.6 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- C. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place and have been properly approved by the local sediment and erosion control agency.

PART 2 - PRODUCTS**2.1 SOIL MATERIALS**

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving."
 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION**3.1 PREPARATION**

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to approved Sediment and Erosion Control Drawings.

- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within fenced area.
 - 2. Do not permit vehicles, equipment, or foot traffic within fenced area.
 - 3. Maintain fenced area free of weeds and trash.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.
 - 1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
 - 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Architect.

3.4 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
 - 1. Construction Manager will arrange to shut off indicated on-site utilities when requested by Contractor.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Construction Manager and Owner not less than five days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Construction Manager's written permission.

- C. Excavate for and remove underground utilities indicated to be removed. Refer to sections covering site utilities.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 - 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
 - 4. Use only hand methods for grubbing within tree protection zone.
 - 5. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials within approved stock pile locations away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Do not stockpile topsoil within tree protection zones.

2. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

A. Disposal: Remove obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property. All soils we are required to remain on site and be incorporated into the project based on the VCP agreement.

B. Stockpile: Surplus soil material, unsuitable soil material and unsuitable topsoil must remain onsite. Owner must be notified immediately if for some reason soil would need to be removed from this parcel of land.

END OF SECTION 311000

SECTION 312000 – EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- 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 repeated herein.

1.2 PROJECT SITE INFORMATION:

- A. The Hazardous Substance Cleanup Act (HSCA) allows for Voluntary Cleanup Program (VCP).
- B. DNREC and DFM have entered into a VCP Agreement at this site (DE-1559). This site has elevated levels of Arsenic in the soil based on sample evidence that was collected. For further details contact Stephen Johnson, DNREC Project Officer at 302-395-2600
- C. All soils we are required to remain on site and be incorporated into the project based on the VCP agreement.
- D. Owner must be notified immediately if for some reason soil would need to be removed from this parcel of land.

1.3 SECTION INCLUDES

- A. Earthwork includes areas below building foundations, below concrete slabs on grade, below paved areas and grading of all unpaved area in the site.
 - 1. Layout and staking for earthwork.
 - 2. Excavation and rough grading.
 - 3. Topsoil redistribution.
 - 4. Erosion and sediment control.
 - 5. Foundation excavation for footings.
 - 6. Establishing subgrades, leveling and proofrolling.
 - 7. Filling, backfilling and compaction.
 - 8. Keeping streets clean of materials tracked off site.
 - 9. Includes trenching, excavation and backfill for utilities.
 - 10. Maintenance and/or repair of damage to the rough grading.
 - 11. Removal and disposal of stones, debris, excess and unsuitable materials.
 - 12. Soil treatment for termite control.
 - 13. Field quality control, testing, and inspection.

1.4 DEFINITIONS

- A. Rock Excavation: Natural geological formations or other material which cannot be removed by adequate equipment (in good condition) as defined below, shall be considered a change in the scope of work and paid for by the Owner if encountered.
 - 1. Open Excavation and Grading: Rock in excess of the capabilities of a Caterpillar D-8 tractor (or equivalent) with 2 cu. yd. bucket and hydraulically operated single tooth power ripper.
 - 2. Trenches, Pits and Footings: Rock in excess of the capabilities of a Caterpillar 235 Hydraulic Backhoe (or equivalent) using a 2 ft. Bucket width (3/4 cu. yd.)
 - 3. Minimum Effort: If rock is not removed during the process of normal digging and ripping, then extend the excavation to expose the rock surface within the limit of original excavation. Contact

the A/E and he may direct the sides of rock to be exposed to a depth of 3 feet. This will be to determine to the extent of additional work.

- B. Earth Excavation: Anything not classified as rock including as example: soils, gravels, stones, boulders, vegetation, debris, and unsuitable materials.
- C. Unsuitable Materials: All excavated materials; debris, man made or fabricated materials, concrete spoil, organic, soft, expansive, or unstable matter; all shall be disposed of as herein specified. Excessive moisture content shall not classify a material as unsuitable.
- D. Removal and disposal of unsuitable material above the subgrade elevation and placement of approved specific fill material (from on or off the site) above the subgrade elevation as directed by the Soils Engineer shall be considered a part of the work.
- E. Owner must be notified immediately if for some reason soil would need to be removed from this parcel of land. No soil material can be removed from the site without prior written permission of Owner.
- F. Soils Engineer or Inspection Agency: An Agency and its designated representatives who monitor and approve all earthwork operations described herein.
- G. Subgrade: The finished elevation of the earth immediately below all slabs, granular and porous fill, paving, footings, walls, etc., except the subgrade elevation shall not be higher than 12" below the existing earth elevation at the start of the project.
- H. Subgrade for utility construction: Underside of barrel of pipe, or underside of any cradle or bedding if noted on drawings, or referenced in applicable local government specifications. For pipe drains and miscellaneous structures encased in concrete or on concrete, stone and/or gravel cradle, subgrade is lowest outside surface of encasement or cradle.
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- K. Drainage Course: Course supporting the slab on grade that also minimizes upward capillary flow of pore water.
- L. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- M. Utilities: On site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- N. Filter Material: Course placed around drainage pipes.

1.5 QUALITY ASSURANCE

- A. Reference Standards:
 1. American Association of State Highway and Transportation Officials (AASHTO).
 2. American Society for Testing and Materials (ASTM).
 3. Delaware Department of Transportation, State Highway Administration "Standard Specifications for Road and Bridge Construction", August 2001, as amended to date (DelDOT as hereinafter referred). Delete references to Measurement and Payment.

- B. Geotechnical Testing Agency Qualifications: An independent testing agency (with a Geotechnical engineer licensed in the state where the project is being constructed on staff) qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.
- C. Tolerances: As indicated herein.
- D. Testing: Requirements as specified herein.

1.6 SUBMITTALS

- A. A. Notification:
 - 1. Notify and provide data to regulatory authorities and A/E prior to commencement of work.
 - 2. Provide notice of: encounter with unknown utilities; subgrades before filling; areas requiring testing or inspection.
- B. Product Data: For the following:
 - 1. Geotextile.
 - 2. Detection Warning Tape.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D2487 of each on site and borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve according to ASTM D1557 for each on site and borrow soil material proposed for fill and backfill.
 - 3. Field reports; in-place soil density tests.
 - 4. One optimum moisture – maximum density curve for each type of soil encountered.
 - 5. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
 - 6. Test reports must be submitted daily to the Architect and Owner.

1.7 PROJECT CONDITIONS

- A. Project Site Information:
 - 1. The Hazardous Substance Cleanup Act (HSCA) allows for Voluntary Cleanup Program (VCP).
 - 2. DNREC and DFM have entered into a VCP Agreement at this site (DE-1559). This site has elevated levels of Arsenic in the soil based on sample evidence that was collected. For further details contact Stephen Johnson, DNREC Project Officer at 302-395-2600
 - 3. All soils we are required to remain on site and be incorporated into the project based on the VCP agreement.
 - 4. Owner must be notified immediately if for some reason soil would need to be removed from this parcel of land.
- B. Subsurface Conditions: Subsurface soils investigations have been made at the site. The report and logs of the test borings and test pits are included in the Appendix of these specifications. Such investigations have been made for the purposes of design only and neither the Engineers, the Owner, nor the Geotechnical Engineer guarantee adequacy or accuracy of the data, or that data are representative of all conditions to be encountered. Such information is made available for general information only and shall not relieve the Contractor of the responsibility for making his own investigations, tests, and analysis. Any additional test borings and other exploratory operations may be made by Contractor shall be at no cost to Owner.

1. See Geotechnical Engineering Report prepared by Hillis Carnes Engineering Associates, Inc. in Division 1 for test boring data and other requirements.
- C. Erosion and sediment control, in addition to erosion control specified in Section 31100 and Division 1:
 1. Standards: Comply with the requirements of the "Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas" by the U.S.D.A. Soil Conservation Service.
 2. General Erosion: Prevent erosion of earthwork; repair and correct any ditches, gullies or erosion immediately and upon occurrence.
 3. Excavations: Prevent water from flowing into open excavations and toward building walls.
 4. Slopes: Cover (with continuous plastic membrane) and stake all slopes steeper than 1.5 horizontal to 1 vertical.
- D. Environmental Conditions:
 1. Do not apply soil treatment when temperature is at or below freezing or when ground is frozen or frost is expected.
 2. Do not apply soil treatment when surface water is present.
- E. Existing Conditions: Accept the site in the condition which it exists at the time of the award of the contract and perform all work to the grades indicated.
 1. Protect plant material, lawns and other features not designated for removal.
 2. Protect bench marks, existing structures, fences, sidewalks, paving and curbs from excavating equipment and vehicular traffic.
- F. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork operations.
 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility Owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility Owner.
 2. Do not interrupt existing utilities serving facilities occupied and used by others, except when permitted in writing by A/E and then only after acceptable temporary utility services have been provided. Provide a minimum of 48 hour notices to utility Owners and receive written notice to proceed before interrupting any utility.
- G. Rock Excavation: Rock excavation may be performed with hoe rams, jack hammers, or any method the Contractor wishes to employ except for explosives.

1.8 PROTECTION

- A. Safety: Provide protective measures necessary for the safety of workmen, to the public and adjacent property. Prevent cave-ins, collapse of walls, structures and slopes, both on and adjacent to the site.
- B. Standards: Comply with regulations of local authorities having jurisdiction, including all applicable O.S.H.A. requirements.
- C. Repair: Includes the removal and replacement with new materials all materials so affected by settlement.

PART 2 - PRODUCTS

2.1 FILL AND BACKFILL

A. Satisfactory Soils:

1. Compacted fill and backfill shall be free of deleterious matter such as frozen materials, organics, wood, debris, or rock larger than 4 inches in diameter and be classified SP, SW, SM, SC, GP, GC, GM, or GW per ASTM D-2487. All material shall have a liquid limit and plasticity index not exceeding 40 and 20 respectively when tested in accordance with ASTM D-4318.
2. The minimum dry unit weight shall not be less than 105 PCF maximum dry density as determined by ASTM D-1557, modified proctor.
3. All fill and backfill materials shall be obtained from on site or from off site sources and shall be approved by the Geotechnical Engineer prior to placement.
4. Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with a least 90 percent passing a 1 ½ inch sieve and not more than 12 percent passing a No. 200 sieve.

1. Locations: All on site fill areas

C. Drainage fill:

1. Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel, (ASTM D 448 Coarse - aggregate grading size 57), with 100% passing of 1-1/2" sieve and not more than 5% passing a No. 8 sieve. Aggregate shall meet DELDOT specification for No. 106A aggregate. Provide by Contractor from off site source.

- a. Locations: All concrete slab on grade areas

2. For foundation drainage, use aggregate meeting DELDOT specification for No. 113 aggregate.

- a. Locations: Drainage fill behind basement walls and retaining walls.

D. Stone Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, reclaimed concrete, and natural or crushed sand (ASTM D2490) with at least 95% passing a 1 ½" sieve and not more than 8% passing a No. 200 sieve. Provide by contractor from off site sources.

E. Subbase Material: Designation CR-6 in accordance with DELDOT Specifications.

1. Locations: All vehicular traffic areas

F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 1 inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve. For utility installations, bedding shall conform to AASHTO #57 stone.

G. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; AASHTO M-43, size No. 17.

H. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

I. Processed Rubble Fill: Existing brick and concrete rubble, free of wood and steel may be processed by use of tracked equipment such that no particle size greater than 6 inches in the longest dimension remains.

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 FILL AND BACKFILL FOR UTILITIES

- A. Backfill: Earth removed from the trench provided that in the opinion of Soils Engineer such excavated material is satisfactory for backfilling.
- B. Should the excavated material be considered unsatisfactory for backfilling, the Contractor shall remove and dispose of such unsatisfactory material and substitute, in lieu thereof, suitable material obtained from elsewhere on or off the site.
- C. Materials shall meet the requirements specified in paragraph 2.1.A above.

2.3 TOPSOIL

- A. Topsoil shall be excavated and reused material supplemented by new material obtained from off site sources as required, to complete the work.
- B. All topsoil shall be graded free of roots, rocks larger than 1", subsoil, debris and organic material.

2.4 SOIL TREATMENT - TERMITE CONTROL

- A. Emulsion soil chemicals of only water-based type. Do not use any fuel oil as a diluent.
- B. Solutions and chemicals listed and approved by EPA, USDA, and Delaware State Department of Agriculture.
- C. Chemicals used in retreatment shall also be certified and state type of chemical and rate of concentration.

2.5 ACCESSORIES

- A. Detectable Warning Tape: Acid and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
 1. Red: Electric
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems
 5. Green: Sewer systems.

2.6 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 1. Survivability: Class 2; AASHTO M 288.
 2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
 3. Sewn Seam Strength: 142 lbf; ASTM D 4632.
 4. Tear Strength: 56 lbf; ASTM D 4533.
 5. Puncture Strength: 56 lbf; ASTM D 4833.
 6. Apparent Opening Size: No. 70 sieve, maximum; ASTM D 4751.
 7. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
4. Tear Strength: 90 lbf; ASTM D 4533.
5. Puncture Strength: 90 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.7 FLOWABLE FILL

- A. Stabilized flowable fly ash mixture with a maximum slump of 8" and a minimum unconfined compressive strength of 100 psi used to fill construction excavations.
- B. Manufacturer: American Stone Mix or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify existing ground surfaces have been stripped of topsoil, root mat and existing pavement, unsatisfactory soils, concrete spoil, obstructions and deleterious material.
- B. Locate underground utilities in areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork operations. Contact "Miss Utility".
- C. Use of explosives will not be permitted, unless approved by Owner in writing and Regulatory Agencies having jurisdiction.
- D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- E. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- F. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- G. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 EXCAVATION

- A. Excavation consists of removal and disposal of material encountered when establishing required finish grade elevations.
- B. Unauthorized Excavations:
 1. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of A/E. Unauthorized excavation, as well as remedial work directed by A/E, shall be at Contractor's expense.

2. Under footings, foundations, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing to excavation bottom, without altering required top elevation. Lean concrete, flo-ash fill, or compacted structural fill may be used to bring elevations to proper position, when acceptable by A/E.

C. Additional Excavation: When excavation has reached required subgrade elevations, notify Soils Engineer who will make an inspection of conditions.

1. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated materials as directed by A/E
2. Removal of unsuitable material below the subgrade elevation and its replacement as directed will be paid by the Owner on basis of contract conditions relative to change in work.

D. Stability of Excavations: Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of materials excavated.

1. Maintain sides and slopes of excavations in safe conditions until completion of backfilling.

E. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition.

1. Establish requirements for trench shoring and bracing to comply with local, State & Federal codes and authorities having jurisdiction.
2. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

F. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Excavations shall be kept free of water for a minimum of two (2) inches below subgrade of excavation. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
2. Convey water removed from excavations and rain water into approved sediment control devices. Establish and maintain temporary drainage ditches and other diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.
3. Excessive groundwater conditions: Refer to Article 4.3.6 of the General Conditions.

G. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.

1. Prevent saturation of soil above the optimum moisture content.
2. Locate and retain soil materials away from edge of excavations.
3. Dispose of excess soil material and waste materials as herein specified.

H. Excavation for Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10', and extending sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. In excavating for footings and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. If in excavating for building foundations the soil directly below the building foundations is disturbed, the disturbed soil shall be removed and shall be recompacted to 95% of the modified standard proctor density and replaced with concrete backfill.

- I. Excavation for Stone and Concrete Pavements: Cut surface under pavements to comply with cross sections, elevations and grades as shown:
 - 1. Where rock or concrete spoil is encountered, carry excavation 18" below subgrade and backfill with suitable material approved by the A/E.
- J. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed with ample working room.
 - 1. Excavate trenches to depth, lines, gradients, and elevations indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze ups.
 - 2. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of pipe.
 - 3. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.
 - a. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 - b. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
 - 4. Backfill trenches with concrete where trench excavations pass within 18" of column or wall footings and which are carried below bottom of such footings, or which pass under wall footings. Place concrete to level of bottom of adjacent footing. Concrete is specified in Division 3.
 - 5. Do not backfill trenches until tests and inspections have been made and backfilling authorized by A/E. Use care in backfilling to avoid damage or displacement of pipe systems.
- K. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F. (1 degree C.).
- L. Ground Surface Preparation (Structural and Pavement areas):
 - 1. The existing ground surface in the structural and pavement areas shall be stripped of topsoil, root mat, existing pavements, unsatisfactory soils, concrete spoil, obstructions and deleterious material. Base course material from the existing pavements may remain if approved by the A/E. The entire area shall be proof rolled, a minimum of four (4) passes, with a loaded dump truck with a minimum axle load of 10 tons in the presence of the soils engineer. Soft spots identified by the Soils Engineer during proofrolling will be undercut and backfilled in accordance with Section 3.4. Proofrolling and compaction equipment shall meet the requirements of Section 3.3.D. Undercutting and backfilling operations for eliminating soft spots above the subgrade elevation shall be included in the base bid.
 - 2. In cut areas, prior to the construction of paving or concrete slab on grade, the entire subgrade shall be proofrolled in the presence of the Soils Engineer. Soft areas encountered during proofrolling shall be undercut and backfilled in accordance with section 3.4. Proofrolling and compaction equipment shall be in compliance with Section 3.3 D. The cost of undercutting and backfilling above the subgrade elevation shall be included in the base bid.
- M. Earthwork Quantities:
 - 1. Contractor shall be responsible for determining earthwork quantities for the completion of the work.

3.3 COMPACTION

- A. General: Control soil compaction during construction providing percentage of dry density specified for each area classification.
- B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of the maximum dry density which is determined in accordance with ASTM D 1557, or in accordance with ASTM D 2049 for soils which will not exhibit a well defined moisture density relationship.
 - 1. Structural, pavement and walkway areas, steps and utility trenches - 95% of the maximum dry density.
 - 2. Lawn areas outside the designated structural fill limits - 90% of the maximum dry density.
- C. Moisture Control: Obtaining a uniformly high degree of compaction requires control over the moisture content of the material being placed in the fills and backfill. The soils used in fill and backfill shall be brought to within 3% of optimum moisture at no additional cost to the Owner.
 - 1. Where the soil layer is too dry, the Contractor shall apply water uniformly using approved equipment to increase the moisture content to within 3% of the optimum, taking precautions to prevent free water from appearing on the surface during or subsequent to compaction operations.
 - 2. Where the soil layer is too wet, the Contractor shall dry the soils by plowing or discing to aerate the soil and reduce the moisture content to within 3% of the optimum.
- D. Compaction equipment shall be as required to complete the scope of work outlined in the geotechnical report, contract documents and specifications for this project.

3.4 BACKFILL AND FILL

- A. General: Place acceptable soil material in layers not more than eight (8) inches in thickness to required subgrade elevations, for each area classification listed below. Each layer shall be compacted to the requirements of Section 3.3B.
 - 1. Fill and backfill within building and pavement limits and in utility trenches shall be structural fill soils meeting the requirements of Section 2.1.A.
 - 2. Under lawn areas outside the designated structural fill limits, backfill and fill soils shall be soils meeting the requirements of Section 2.1.A, or other on site materials approved by the Geotechnical Engineer.
 - 3. Fill and backfill located below walkways and steps shall be constructed of structural fill soils meeting the requirements of Section 2.1.A.
 - 4. Drainage fill material shall be proof rolled to a uniform stable condition prior to placement of vapor retarder.
 - 5. Stone base course shall be compacted to 95% maximum dry density per ASTM D-1557.
- B. Backfill excavations as promptly as work permits, but not until completion of the following:
 - 1. Acceptance of construction below finish grade including, where applicable, subdrainage damp proofing, waterproofing, and perimeter insulation.
 - 2. Concrete and masonry have cured 28 days and is adequately braced.
 - 3. Inspection, testing, approval, and recording locations of underground utilities.
 - 4. Removal of concrete formwork.
 - 5. Removal of trash and debris.
 - 6. Removing temporary shoring and bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- C. Ground surface preparation: Shall be in accordance with Section 3.2K.

1. When existing ground surface has density less than that specified under Section 3.3B for particular area classification, break up ground surface, pulverize, moisture condition to optimum moisture content, and compact to required depth and percentage of maximum dry density.
- D. Placement and Compaction: Place backfill and fill materials in layers not more than 8" in loose depth, for material compacted by heavy compaction equipment and not more than 4" in loose depth for material compacted by hand operated tampers.
 1. Before compaction, moisten or aerate each layer as may be necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density for each classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 2. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying material uniformly around structure to approximately same elevation in each lift.
 3. Structural fill shall extend a minimum of five (5) feet beyond building and road pavement limits and shall include the support slopes to their full width.
 4. Backfilling against pipe structures, whose joints involve the use of cement mortar or other concrete, or where buttresses are constructed, shall not be done until mortar has set at least 12 hours.
 5. Compaction over one foot above the pipe shall be done with approved mechanical tampers. Compaction density shall be as specified in Section 3.3.
- E. Utility trench backfill
 1. Place and compact initial backfill of subbase material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
 2. Coordinate backfilling with utilities testing.
 3. Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.
 4. Fill voids with approved backfill materials while shoring, bracing, and sheeting is removed.
 5. Place and compact final backfill of satisfactory soil material to final subgrade.
 6. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.5 ROUGH GRADING

- A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surfaces with specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades. In fill areas, sloped surfaces steeper than 5 horizontal to 1 vertical shall be benched so that fill materials will be placed on a level surface. All fill subgrades shall be observed by the Geotechnical Engineer.
- B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes, and as follows:
 1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10' above or below required subgrade elevations.
 2. Walks: Shape surface or areas under walks to line, grade and cross section, with finish surface not more than .04' above or below required subgrade elevation.
 3. Pavements: Shape surface areas under pavement to line, grade and cross section, with finish surface not more than .04' for bituminous surfaces and 08' for stone surfaces, above or below required subgrade elevation.

C. Grading Surface or Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of .02' when tested with a 10' straightedge.

3.6 TOPSOIL REDISTRIBUTION

A. General: Topsoil shall be stockpiled on site in the area(s) identified on the contract drawings.

B. Placing: Upon completion of final site grading, excess topsoil shall be redistributed in the area(s) shown on the contract drawings, in compliance with the following criteria:

1. Slopes not less than 1% and not more than 6%.
2. Depth not to exceed 30 inches.
3. Drainage areas and flow paths may not be changed from the preconstruction condition.
4. Drainage onto and off of adjacent properties shall not be changed.
5. Redistributed topsoil shall be stabilized within 48 hours of placement.
6. Redistributed topsoil shall be planted with the permanent seeding mixture and associated installation requirements, detailed in this section.

3.7 BUILDING SLAB BASE COURSE

A. General: Slab base course consists of placement of drainage fill or stone base course material, in layers of indicated thickness, over subgrade surface to support concrete building slabs.

B. Placing: Place slab base course on prepared subgrade in layers of uniform thickness, conforming to indicate cross section and thickness. Maintain optimum moisture content for compacting material during placement operations.

1. When a compacted drainage course is shown to be 6" thick or less, place material in a single layer. Where shown to be more than 6" thick, place material in equal layers, except no single layers more than 6" or less than 3" in thickness when compacted.

C. Any ruts or soft yielding spots which may occur or any areas having inadequate compaction or deviations from the requirements set forth herein shall be corrected by removing and adding uniformly graded crushed stone or by loosening crushed gravel, reshaping and recompacting. The subgrade shall have a uniform density throughout its entire depth and width and shall be approved by the A/E prior to pouring any concrete.

D. Following this preparation, the subgrade shall be protected from damage as described below:

1. The subgrade shall be protected from damage by heavy loads or equipment moving on tracks or cleats.
2. The contractor shall at all times keep the subgrade drained.
3. No concrete shall be deposited upon a frozen subgrade nor, until the subgrade has been approved by the A/E.
4. Immediately in advance of placing concrete, the subgrade shall be sprinkled with as much water as it can readily absorb.

3.8 FINISH GRADING

A. Verify surfaces are to the prescribed subgrades, within tolerances and properly compacted.

B. Remove mounds or ridges, gullies and depressions and perform other necessary repairs.

C. Tillage: After the areas to be topsoiled have been approved for proper subgrade, the surface shall be loosened and made friable by cross-discing or other satisfactory methods, to a depth of at least 2" to permit bonding of topsoil to the subgrade.

D. Remove stones and debris 1 inch or more in any dimension from the surface of the subgrade.

3.9 PLACING TOPSOIL

A. Topsoil shall not be placed when either the subgrade or the topsoil is wet or frozen enough to cause clodding.

B. Spread stockpiled topsoil evenly over designated lawn areas to a depth of 6 inches.

C. Finished surface of topsoiled areas shall have a maximum vertical tolerance of 0.10 foot.

3.10 MAINTENANCE

A. Protection of graded areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Repair and re establish grades in settled, eroded and rutted areas to specified tolerances.

B. Reconditioning compacted areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

C. Restore areas previously occupied by stockpiled materials to match finished condition of the remainder of the work.

3.11 APPLICATION OF SOIL TREATMENT

A. Do not apply soil treatment until preparations for slab placements are complete, including backfilling, and placement of base course, grading, and soil compaction.

B. Complete treatment application prior to placement of vapor retarders and insulation.

C. Take particular care not to disturb the subgrade after treatment.

D. Apply soil treatment at rates recommended by manufacturer to the following areas: Area of earth fill within the limit of the building; coarse or porous fill; voids of foundations walls; beneath concrete floor slabs; along, and adjacent to interior and exterior sides of foundation walls, beams and footings; immediately below expansion joints, control joints and areas where slabs will be penetrated by construction features; where exterior facings or veneers extend below grade level along exterior side of foundation walls, or where unit masonry foundation construction is used.

3.12 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from Owner's Property: Remove waste materials including trash, debris, and unsuitable and excess excavated material, and dispose of off Owner's property only after requesting and receiving Owner's written approval of such activities.

3.13 FIELD QUALITY CONTROL – SOILS

A. Quality Control Testing During Construction: Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.

1. Perform field density tests in accordance with ASTM D 1556 (sand cone method) or ASTM D 2922 and D-3017(shallow depth nuclear method), as applicable.

2. Paved Areas and Building Slab Subgrade: Make at least one field density test of subgrade for every 2,000 sq. ft. of paved area or building slab area, but in no case less than 3 tests. In each compacted fill layer, make one field density test for every 2,000 sq. ft. of overlaying building slab or paved area, but in no case less than 2 tests. Field density tests shall be made at all walkway entrances and ramps into the proposed building.
3. Foundation Wall Backfill: Take enough field density tests to ensure backfill is being properly compacted.
4. Utility Trench Backfill: Perform field density tests on a spot-check basis to assist the Contractor in determining if compaction is in accordance with the specifications.
5. If in opinion of A/E, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense.
6. Footing Subgrade: For each strata of soil on which footings will be placed, conduct at least one test to verify required design bearing capacities. Subsequent evaluation and approval of each footing subgrade should be performed by Geotechnical Testing Agency.
7. Costs of testing and inspection shall be borne by the Contractor.

3.14 FIELD QUALITY CONTROL - SOIL TREATMENTS

- A. Pay costs for required testing of termite control materials. Samples shall be taken and analyzed by an independent testing laboratory.
- B. Sampling: Test one sample of working solution for each 10,000 square feet of area applied. Take samples from discharge end of spraying equipment for each batch mixed and applied if less than 10,000 square feet.
- C. Retreating: Retreat all areas if the test results average less than 90 percent of listed minimum concentration.

3.15 TESTING AND INSPECTION

- A. INSPECTION AGENCY: Contractor shall employ an Independent Testing agency acceptable to the Architect for purposes of inspecting and testing construction of embankments, fills, backfills, trenches, and subgrades and report to the A/E conformance in all particulars to specification requirements.
- B. Scheduling:
 1. Assign qualified personnel to be on site at all times when operations are scheduled.
 2. The Contractor should note that no earthwork operation shall be permitted in their absence.
- C. Responsibilities:
 1. Evaluation of subgrade preparation and suitability.
 2. Moisture content and field density tests on all layers of fill and backfill material placed.
 3. Evaluation of degree of compaction attained for all fill and backfill material placed.
 4. Testing and evaluation of borrow material.
 5. Sources of borrow and of select fill.
 6. Footing subgrade suitability.
 7. Inspection of installation of Subdrainage system.
- D. Results of Tests:
 1. Make results available to the Soils Engineer and A/E immediately upon completion of areas of layers.

E. Final Report: The Inspection Agency shall prepare a written report that summarizes the work inspected during the course of the project. A discussion of all deviations from the contract documents and specifications, with their related impact on the final construction, shall be described in detail. The engineer of record shall review this final report, and recommend corrective measures (as deemed necessary) that must be made prior to final acceptance of the work. Prior to final payment, a written report certifying that the work meets the requirements of the contract documents, specifications, and all governing agencies shall be prepared, submitted, and approved by the A/E.

END OF SECTION 312000

SECTION 312319 - DEWATERING

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 construction dewatering.

- B. Related Sections include the following:

1. Division 01 Section "Temporary Construction Utilities, Facilities and Controls" for temporary utilities and support facilities.
2. Division 31 Section "Earth Moving" for excavating, backfilling, site grading and for site utilities.
3. Division 31 Section "Excavation Support and Protection."

1.3 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.

1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
2. Prevent surface water from entering excavations by grading, dikes, well pointing or other means.
3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
4. Remove dewatering system if no longer needed.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.
- B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by School District and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
 2. The geotechnical report is included elsewhere in the Project Manual.

C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids

inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 OBSERVATION WELLS

A. Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated and additional observation wells as may be required by authorities having jurisdiction.

B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.

C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. Suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.

1. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

END OF SECTION 312319

SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Soil and wood treatment with termiticide.

- B. Related Sections:

- 1. Division 06 Section "Rough Carpentry" for wood preservative treatment by pressure process.
 - 2. Division 07 Section "Sheet Metal Flashing and Trim" for custom-fabricated, metal termite shields.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of termite control product.

- 1. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

- B. Product Certificates: For termite control products, from manufacturer.

- C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

- 1. Date and time of application.
 - 2. Moisture content of soil before application.
 - 3. Termiticide brand name and manufacturer.
 - 4. Quantity of undiluted termiticide used.
 - 5. Dilutions, methods, volumes used, and rates of application.
 - 6. Areas of application.
 - 7. Water source for application.

- D. Wood Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

- 1. Date and time of application.
 - 2. Termiticide brand name and manufacturer.
 - 3. Quantity of undiluted termiticide used.
 - 4. Dilutions, methods, volumes used, and rates of application.
 - 5. Areas of application.

- E. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located.
- B. Regulatory Requirements: Formulate and apply termiticides and termicide devices according to the EPA-Registered Label.
- C. Source Limitations: Obtain termite control products from single source.
- D. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
- B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.
- C. Apply wood treatment after framing, sheathing, and exterior weather protection is completed but before electrical and mechanical systems are installed.
- D. Install polymer sheet barrier system with termicide prior to placing concrete slab reinforcement and pouring concrete and after installation and inspection of footings, foundations, and plumbing and electrical pipes and conduits.
- E. Install polymer barrier fittings with termicide around utility penetrations prior to pouring concrete and after installation and inspection of plumbing and electrical pipes and conduits, slab vapor barrier, and concrete slab reinforcement.

1.7 WARRANTY

- A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termicide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Wood Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied wood termicide treatment, will prevent infestation of subterranean termites. If subterranean termite damage is discovered during warranty period, repair or replace damage caused by termite infestation and treat replacement wood.
 - 1. Warranty Period: 12 years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

- A. Continuing Service: Beginning at Substantial Completion, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

PART 2 - PRODUCTS**2.1 SOIL TREATMENT**

A. Termitecide: Provide an EPA-Registered termitecide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termitecide concentration allowed for each specific use, according to product's EPA-Registered Label.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Corporation, Agricultural Products; Termidor.
 - b. Bayer Environmental Science; Premise 75.
 - c. FMC Corporation, Agricultural Products Group; Dragnet FT.
 - d. Syngenta; Demon TC.
2. Service Life of Treatment: Soil treatment termitecide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termitecides may be applied before placing compacted fill under slabs if recommended in writing by termitecide manufacturer.
 1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

3.3 APPLICATION, GENERAL

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.4 APPLYING SOIL TREATMENT

- A. Application: Mix soil treatment termitecide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termitecide,

according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.

1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
3. Crawlspaces: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
4. Masonry: Treat voids.
5. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

- B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
- D. Post warning signs in areas of application.
- E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313116

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

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. Project Site Information:

1. The Hazardous Substance Cleanup Act (HSCA) allows for Voluntary Cleanup Program (VCP).
2. DNREC and DFM have entered into a VCP Agreement at this site (DE-1559). This site has elevated levels of Arsenic in the soil based on sample evidence that was collected. For further details contact Stephen Johnson, DNREC Project Officer at 302-395-2600
3. All soils we are required to remain on site and be incorporated into the project based on the VCP agreement.
4. Owner must be notified immediately if for some reason soil would need to be removed from this parcel of land.

B. This Section includes temporary excavation support and protection systems.

C. Related Sections include the following:

1. Division 01 Section "Temporary Construction Utilities, Facilities and Controls" for temporary utilities and support facilities.
2. Division 31 Section "Earth Moving" for excavating and backfilling and for existing utilities.
3. Division 31 Section "Dewatering" for dewatering excavations.

1.3 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Provide professional engineering services needed to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, pavements, and other improvements adjacent to excavation.

1.4 SUBMITTALS

A. Shop Drawings for Information: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.

1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

B. Qualification Data: For Installer and professional engineer.

C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems.

1.5 PROJECT CONDITIONS

- A. Project Site Information:
 - 1. The Hazardous Substance Cleanup Act (HSCA) allows for Voluntary Cleanup Program (VCP).
 - 2. DNREC and DFM have entered into a VCP Agreement at this site (DE-1559). This site has elevated levels of Arsenic in the soil based on sample evidence that was collected. For further details contact Stephen Johnson, DNREC Project Officer at 302-395-2600
 - 3. All soils we are required to remain on site and be incorporated into the project based on the VCP agreement.
 - 4. Owner must be notified immediately if for some reason soil would need to be removed from this parcel of land.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
- C. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
 - 2. The geotechnical report is included elsewhere in the Project Manual.
- D. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 - 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.

- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
 - 1. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.
 - 2. END OF SECTION 315000

SECTION 321216 - ASPHALT PAVING**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. Asphalt paving.
2. Asphalt patching.
3. Asphalt paving overlay.
4. Asphalt surface treatments.
5. Pavement-marking paint.
6. Cold milling of existing asphalt pavement.

- B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.3 DEFINITIONS

- A. Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.
- B. DOT: Delaware Department of Transportation.

1.4 SYSTEM DESCRIPTION

- A. Provide hot-mix and warm-mix asphalt paving according to materials, workmanship, and other applicable requirements of Specifications for road and Bridge Construction of the Delaware Department of Transportation.
 - 1. Standard Specification: Division 400(Division 400), including all updates.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
- B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C. Job-Mix Designs: For each job mix proposed for the Work.
- D. Qualification Data: For manufacturer.
- E. Material Test Reports: For each paving material.
- F. Material Certificates: For each paving material, signed by manufacturers.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer.
 - 1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.
- C. Regulatory Requirements: Comply with Delaware Department of Transportation Specifications for Road and Bridge Construction for asphalt paving work.
- D. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.
- E. Asphalt-Paving Publication: Comply with AASHTO R 35, "Standard Practice for Superpave Volumetric Design for Hot-Mix Asphalt (HMA)," unless more stringent requirements are indicated.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to warm-mix and hot-mix asphalt paving including, but not limited to, the following:
 - 1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture warm-mix and hot-mix asphalt.
 - 2. Review condition of subgrade and preparatory work.
 - 3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
 - 4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp. Adhere to specifications in Delaware Department of Transportation Specifications for Road and Bridge Construction.
- B. Pavement-Marking: Proceed with pavement marking only on clean, dry surfaces and at minimum ambient or surface temperatures specified in the Delaware Department of Transportation Specifications for Road and Bridge Construction.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Materials: All materials used under this section shall conform to the requirements of Delaware Department of Transportation Specifications for Road and Bridge Construction, including, but not limited to: graded aggregate, asphalt cement, and tack coat.
- B. Herbicide Treatment: Commercial chemical for weed control, registered by Environmental Protection Agency. Provide granular, liquid or wettable powder form. Obtain written approval from The Department of Natural Resources and Environmental Control (DNREC) prior to application of the herbicide.
 - 1. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - a. Ciba-Geigy Corp.
 - b. Dow Chemical, USA
 - c. E.I. Du Pont de Nemours & Co., Inc.
 - d. FMC Corp
 - e. Thompson-Hayward Chemical Co.
 - f. U.S. Borax and Chemical Corp.
 - g. Allied Chemical Corp.
 - h. Ag-Chem Products, Inc.
- C. Lane Marking Paint: Paint shall comply with Division 700 of the Delaware Department of Transportation Specifications for Road and Bridge Construction.
 - 1. Color: White
 - 2. Color: Yellow
 - 3. Color: Blue
- D. Joint Sealants: Joint Sealants shall comply with Delaware Department of Transportation Specifications for Road and Bridge Construction, Divisions 700 & 800.

2.2 MIXES

- A. Warm-Mix and Hot-Mix Asphalt: Provide Plant Mixed, warm-laid or hot-laid, asphalt-aggregate mixture complying with Delaware Department of Transportation Specifications for Road and Bridge Construction, Division 400 and referred Divisions.

PART 3 - EXECUTION**3.1 SURFACE PREPARATION**

- A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

- C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
 - 1. Mix herbicide with if formulated by manufacturer for that purpose.
 - 2. Remove spillages and clean affected surfaces.
- D. Proceed with paving only after unsatisfactory conditions have been corrected.
- E. Tack Coat: Apply to contact surfaces of previously constructed asphalt or Portland cement concrete and surfaces abutting or projecting into hot-mixed asphalt pavement. Distribute at a rate of 0.05 to 0.15 gal. Per sq. yd. of surface in accordance Section 401 of the Delaware Department of Transportation Specifications for Road and Bridge Construction.
- F. Allow to dry until at proper condition to receive paving.
- G. Exercise care in applying bituminous materials to avoid smearing of adjoining concrete surfaces. Remove and clean damaged surfaces.

3.2 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
 - 1. Mill to a depth of as specified on plans.
 - 2. Mill to a uniform finished surface free of gouges, grooves, and ridges.
 - 3. Control rate of milling to prevent tearing of existing asphalt course.
 - 4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
 - 5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled asphalt.
 - 6. Transport milled asphalt to asphalt recycling facility.
 - 7. Keep milled pavement surface free of loose material and dust.

3.3 PATCHING

- A. Warm-Mix and Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompack existing unbound-aggregate base course to form new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
 - 1. Pump hot undersealing asphalt under rocking slabs until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
 - 2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompack existing unbound-aggregate base course to form new subgrade.
- C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Patching: Fill excavated pavements with asphalt base mix and, while still above specified laying temperature, compact flush with adjacent surface.
- E. Patching: Partially fill excavated pavements with asphalt base mix and, while still above specified laying temperature, compact. Cover asphalt base course with compacted, surface layer finished flush with adjacent surfaces.

3.4 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of warm mix or hot mix, as specified, asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
 1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
 1. Clean cracks and joints in existing asphalt pavement.
 2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
 3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.5 WARM-MIX AND HOT-MIX ASPHALT PLACING

- A. Machine place asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 1. Place asphalt base course in number of lifts and thicknesses indicated.
 2. Place asphalt surface course in single lift.
 3. Spread mix at minimum temperature required by Division 400.
 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
- C. Immediately correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course. Joints shall

comply with Delaware Department of Transportation Specifications for Road and Bridge Construction, Section 401.12.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
5. Compact joints as soon as asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.7 COMPACTION

- A. General: Begin compaction as soon as placed paving will bear roller weight without excessive displacement. Compact paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while asphalt is still of sufficient temperature to achieve specified density. Continue rolling until asphalt course has been uniformly compacted to the following density:
 1. Density – Surface Course: Degree of compaction not less than 93 percent nor greater than 100 percent of the theoretical voidless density based on laboratory density testing in accordance with AASHTO T 209. During Construction the degree of compaction shall be determined through measurement of in-place pavement density using a nuclear density gauge in accordance with ASTM D 2950 and a laboratory compacted specimen density using the maximum specific gravity and shall be expressed as a percentage.

$$\text{Degree of Compaction} = (\text{Pavement Density} / \text{Theoretical Voidless Density}) \times 100$$

2. Density – Base Course: Degree of compaction not less than 92 percent nor greater than 98 percent of the theoretical voidless density based on laboratory density testing in accordance with AASHTO T 209. During construction the degree of compaction shall be determined through measurement of in-place pavement density using a nuclear density gauge in accordance with ASTM D 2950 and a laboratory compacted specimen density using the maximum specific gravity and shall be expressed as a percentage.

$$\text{Degree of Compaction} = (\text{Pavement Density} / \text{Theoretical Voidless Density}) \times 100$$

- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still at sufficient temperature; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, specified asphalt. Compact by rolling to specified density and surface smoothness.

- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 3/8 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/4 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Contractor shall provide striping on parking and roadway surfaces as indicated on the plans. The following is a list of all required striping:
 - 1. Parking stalls.
 - 2. Cross-hatch/gore areas.
 - 3. Handicap Parking symbols.
 - 4. Stop bars.
 - 5. Directional arrows.
 - 6. Lane lines.
 - 7. Words/numbers.
- C. Allow paving to age for 30 days before starting pavement marking.
- D. Sweep and clean surface to eliminate loose material and dust.
- E. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
 - 1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal. for all markings with the exception of parking stall lines.

3.10 WHEEL STOPS

- A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop. Wheel stops shall be parallel to the edge of pavement.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.
 - 1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.
- B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C. Thickness: In-place compacted thickness of asphalt courses will be determined according to ASTM D 3549.
- D. Surface Smoothness: Finished surface of each asphalt course will be tested for compliance with smoothness tolerances.
- E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
 - 1. Reference maximum theoretical density will be determined by averaging results from four samples of asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 - 2. In place compaction shall be based on laboratory testing in accordance with AASHTO T 209 by obtaining cores of in place material. 6" (100 mm) diameter, diamond-bit drilled roadway cores shall be obtained from the constructed pavement mixtures for laboratory pavement density determination at a rate of 2 cores per 500 tons of material.
 - 3. Density – Surface Course – Not less than 93 percent and not greater than 100 percent of the theoretical voidless density
 - 4. Density – Base Course – Not less than 92 percent and not greater than 98 percent of the theoretical voidless density
- F. Remove and replace or install additional asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.12 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow excavated materials to accumulate on-site.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING**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 exterior cement concrete pavement for the following:

1. Driveways and roadways.
2. Parking lots.
3. Curbs and gutters.
4. Walkways.
5. Unit paver base.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
2. Division 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.
3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants of joints in concrete pavement and at isolation joints of concrete pavement with adjacent construction.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Samples: 10-lb sample of exposed aggregate.

D. Qualification Data: For manufacturer. Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

E. Material Test Reports: General contractor will engage a qualified testing agency for indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

F. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials.

2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

G. Field quality-control test reports.

H. For plazas and wide walkways, submit control joint spacing plan for review.

I. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete producer.
 - d. Concrete pavement subcontractor.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. 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.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

C. Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, plain steel.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

H. Plain Steel Wire: ASTM A 82, as drawn.

I. Deformed-Steel Wire: ASTM A 496.

J. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain.

K. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

- L. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain steel bars.
- M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- N. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- O. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.
- P. Zinc Repair Material: ASTM A 780.

2.4 CONCRETE MATERIALS

- A. Materials: All materials including but not limited to reinforcing materials, concrete materials, concrete mix, admixtures, curing materials, traffic paint and other related materials used under this section shall conform to the requirements of the Delaware Department of Transportation Specifications for Road and Bridge Construction. References to a required class of concrete shall correspond to the classes as shown in the State of Delaware Department of Transportation Specifications for Road and Bridge Construction Division 500 and Division 800.
- B. Fly ash shall meet the approval of the ASTM C-618 pozzolan Class F and may be used as a partial substitute for cement when approved by the Architect.
- C. The concrete mix used in performing this work shall be DelDOT Class "A" or DelDOT Class "B" depending on the compressive strength shown on the details and shall meet the approval of the Architect.
- D. The concrete temperature shall not exceed 90°F when delivered to the job-site or at any time prior to placement in the forms.
- E. Type I - Portland Cement: Shall be used from October 1 through May 1 and when the air temperature in the shade and away from artificial heat is above 70°F or less, or as directed by the Architect.
- A. Type II - Portland Cement: Shall be used from May 1 through October 1 and when the air temperature in the shade and away from artificial heat is above 70°F, or as directed by the Architect.
- F. When approved by the Architect, Hi-Early strength concrete may be used. Approval will be on a case by case basis.
- G. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
 - 1. Aggregate Sizes: 1/2 to 3/4 inch nominal.
 - 2. Aggregate Source, Shape, and Color: Submit color samples for review by Architect and owner
- H. Water: ASTM C 94/C 94M.

- I. Air-Entraining Admixture: ASTM C 260.
- J. Chemical Admixtures: Admixtures may only be used with prior approval by the Architect. Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 FIBER REINFORCEMENT

- A. Synthetic Fiber: fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.
 - 1. Available Products:
 - a. Fibrillated Fibers:
 - 1) Axim Concrete Technologies; Fibrasol F.
 - 2) FORTA Corporation; Forta.
 - 3) Euclid Chemical Company (The); Fiberstrand F.
 - 4) Grace, W. R. & Co.--Conn.; Grace Fibers.
 - 5) SI Concrete Systems; Fibermesh.

2.6 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
 - 1. Available Products:
 - a. Axim Concrete Technologies; Cimfilm.
 - b. Burke by Edeco; BurkeFilm.
 - c. ChemMasters; Spray-Film.
 - d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film.
 - f. Euclid Chemical Company (The); Eucobar.
 - g. Kaufman Products, Inc.; Vapor Aid.
 - h. Lambert Corporation; Lambco Skin.
 - i. L&M Construction Chemicals, Inc.; E-Con.
 - j. MBT Protection and Repair, ChemRex Inc.; Confilm.
 - k. Meadows, W. R., Inc.; Sealtight Evapre.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
 - n. Sika Corporation, Inc.; SikaFilm.

- o. Symons Corporation; Finishing Aid.
- p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

E. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

1. Available Products:

- a. Anti-Hydro International, Inc.; AH Curing Compound #2 WP WB.
- b. Burke by Edoco; Resin Emulsion White.
- c. ChemMasters; Safe-Cure 2000.
- d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
- e. Dayton Superior Corporation; Day-Chem White Pigmented Cure (J-10-W).
- f. Euclid Chemical Company (The); Kurez VOX White Pigmented.
- g. Kaufman Products, Inc.; Thinfilm 450.
- h. Lambert Corporation; Aqua Kure-White.
- i. L&M Construction Chemicals, Inc.; L&M Cure R-2.
- j. Meadows, W. R., Inc.; 1200-White.
- k. Symons Corporation; Resi-Chem White.
- l. Tamms Industries, Inc.; Horncure 200-W.
- m. Unitex; Hydro White.
- n. Vexcon Chemicals, Inc.; Certi-Vex Enviocure White 100.

2.7 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. Chemical Surface Retarder: (For exposed aggregate concrete) Water-soluble, liquid-set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.
 - 1. Products:
 - a. Burke by Edoco; True Etch Surface Retarder.
 - b. ChemMasters; Exposee.
 - c. Conspec Marketing & Manufacturing Co., Inc.; Delay S.
 - d. Euclid Chemical Company (The); Surface Retarder S.
 - e. Kaufman Products, Inc.; Expose.
 - f. Metalcrete Industries; Surf tard.
 - g. Nox-Crete Products Group, Kinsman Corporation; Crete-Nox TA.
 - h. Scofield, L. M. Company; Lithotex.
 - i. Sika Corporation, Inc.; Rugasol-S.
 - j. Vexcon Chemicals, Inc.; Certi-Vex Envioset.

2.8 WHEEL STOPS

A. Wheel Stops: Solid, 3000 PSI concrete, precast.

1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

2.9 ADA TRUNCATED DOMES

- A. General: Reference DelDOT specifications section 705007.
 1. Construction shall be in accordance with the Americans with Disabilities Act (ADA) as most recently amended.
 2. Approved Materials include precast concrete, or fired clay brick paver units: manufactured with the truncated dome pattern, set on the concrete surface. Cast Iron plants, stamping systems, or fiberglass systems are not permitted within the written approval of the architect.
 3. Contractor shall submit concrete or paver colors to the Architect for approval prior to construction.

2.10 CONCRETE MIXTURES

- A. The concrete mix used in performing this work shall be DelDOT Class "A" or DelDOT Class "B" depending on the compressive strength shown on the details and shall meet the approval of the Architect.
- B. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
 1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.
- C. Proportion mixtures to provide normal-weight concrete with the following properties:
 1. Compressive Strength (28 Days): 4500 psi or 3000 psi. depending on location
 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
 3. Slump Limit: 2-5, plus or minus 1 inch.
- D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 1. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.
- E. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- F. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 1. Use water-reducing admixture, plasticizing and retarding admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- G. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals. Limits shall be as follows per DelDOT requirements:
 1. Fly Ash or Pozzolan: 25 percent.
 2. Ground Granulated Blast-Furnace Slag: 50 percent.

3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- H. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd..

2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116 where synthetic fibers are noted on the plans. Furnish batch certificates for each batch discharged and used in the Work.
 1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
 2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
 3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."
- C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
 - 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
 - 2. Provide tie bars at sides of pavement strips where indicated.
 - 3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 20 feet, unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. All Isolation Joints shall be treated with joint filler.
 - 4. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface.
 - 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated but not less than 5 feet. For larger walkways, width greater than 12' and plazas, submit shop drawing of joint pattern. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
 - 2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Scree pavement surfaces with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

K. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

L. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

M. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

N. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Construct test sections of each type of concrete paving, including at least one expansion joint and control joints, for review by CM, Owner and Architect for agreement of finish prior to starting concrete installation. Review will include texture of broom finish, joint striking, picture framing and geometric conformity.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
3. Incorporate "picture framing" of concrete in finish within lump sum prices bid.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 1. Elevation: 1/4 inch.
 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/4 inch.
 4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
 5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
 6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
 8. Joint Spacing: 3 inches.
 9. Contraction Joint Depth: Plus 1/4 inch, no minus.
 10. Joint Width: Plus 1/8 inch, no minus.

3.10 WHEEL STOPS

- A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded in holes drilled or cast into wheel stops at one-quarter to one-third points. Firmly bond each dowel to wheel stop and to pavement. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

- C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.12 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 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. Expansion and contraction joints within cement concrete pavement.

- B. Related Sections include the following:

- 1. Division 07 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.
 - 2. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.

- B. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:

- 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet or covered with frost.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

2.3 COLD-APPLIED JOINT SEALANTS

A. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.

1. Products:

- a. Crafco Inc.; RoadSaver Silicone.
- b. Dow Corning Corporation; 888.

2.4 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

PART 3 - EXECUTION**3.1 EXAMINATION**

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

- C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of backer materials.
 - 2. Do not stretch, twist, puncture, or tear backer materials.
 - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses provided for each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealants from surfaces adjacent to joint.
 - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.
- G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 321373

SECTION 323113 - SECURITY FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Vinyl coated galvanized steel chain-link fabric.
 - 2. Vinyl coated galvanized steel framework.
 - 3. Swing Gates.
- B. Division 31 Section "Earth Moving" for filling and grading work.
- C. Division 03 Section "Cast-in-Place Concrete" for concrete for post footings.
- D. Grounding requirements for fence and gates are specified in Section 16452 "Grounding."

1.2 REFERENCES

A. American Society for Testing and Materials

- 1. A90/A90M - Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- 2. A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- 3. A924/A924M - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- 4. B6 - Specification for Zinc.
- 5. B117 - Practice for Operating Salt Spray (Fog) Apparatus.
- 6. D1499 - Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Plastics.
- 7. D3359 - Test Methods for Measuring Adhesion by Tape Test.
- 8. E8/E8M - Test Methods for Tension Testing of Metallic Materials.
- 9. F567 - Practice for Installation of Chain-Link Fence. F626 - Specification for Fence Fittings.
- 10. F668 - Specification for Poly (Vinyl Chloride) (PVC)- Coated Steel Chain-Link Fence Fabric.
- 11. F900 - Specification for Industrial and Commercial Swing Gates.
- 12. F934 - Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
- 13. F969 - Practice for Construction of Chain-Link Tennis Court Fence.
- 14. F1043 - Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
- 15. F1184 - Specification for Industrial and Commercial Horizontal Slide Gates. F1665 - 08(2013) F1665 - 08(2013) Poly(Vinyl Chloride) (PVC)
- 16. A 121: Zinc-Coated (Galvanized) Steel Barbed Wire
- 17. A 123: Specifications for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strip.
- 18. A 392: Zinc-Coated Steel Chain-Link Fence Fabric
- 19. B 117: Standard Test Method of Salt Spray (Fog) Testing
- 20. F 1083: Standard Specifications for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

B. Federal Specifications (FS)

- 1. RR-F-191: Fencing, Wire and Post, Metal (and Gates, Chain-Link Fabric, and Accessories)
CHAIN LINK FENCES AND GATES

1.3 DEFINITIONS

- A. CLFMI: Chain Link Fence Manufacturers Institute.
- B. Zn-5-Al-MM Alloy: Zinc-5 percent aluminum-mischmetal alloy.

1.4 SUBMITTALS

- A. Product Data: Material descriptions, construction details, dimensions of individual components and profiles, and finishes for the following:
 1. Fence and gate posts, rails, tension wire and fittings.
 2. Black vinyl fence post and fence fabric color samples.
 3. Chain-link fabric, reinforcements, and attachments.
 4. Gates and hardware.
 5. Gate operators, including operating instructions.
 6. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
- B. Shop Drawings: Show locations of fence, each gate, posts, rails, and tension wires and details of extended posts, extension arms, gate swing, or other operation, hardware, and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, elevations, sections, gate swing and other required installation and operational clearances, and details of post anchorage, footings and attachment and bracing.
 1. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
 2. Wiring Diagrams: Power and control wiring and access control features. Differentiate between manufacturer-installed and field-installed wiring and between components provided by gate operator manufacturer and those provided by others.
- C. Product Certificates: Signed by manufacturers of chain-link fences and gates certifying that products furnished comply with requirements.
- D. 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.
- E. Field Test Reports: Indicate and interpret test results for compliance of chain-link fence and gate grounding and bonding with performance requirements.
- F. Maintenance Data: For the following to include in maintenance manuals specified in Section 01782, "Operation and Maintenance Manual Data":
 1. Gate operator and motor.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed chain-link fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association 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 for Chain-Link Fences and Gates: Obtain chain-link fences and primary personnel gates, including accessories, fittings and fastenings from a single source.
- 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. UL Standard: Provide gate operators that comply with UL 325 "Standards for Safety for Drapery, Gate, Louver and Window Operators."
- F. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators serving as a required means of access.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 1. Notify Contracting Owner not less than 2 working days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Owner's written permission.
- B. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to actual field conditions and existing structures and utilities. Verify dimensions by field measurements.

1.7 MISCELLANEOUS REQUIREMENTS

- A. Deliver, store, uncrate, handle and install in manner to prevent damage to equipment.
- B. Remove promptly from site all debris resulting from installation of materials and equipment specified herein.
- C. Finish of all materials and equipment shall be appropriate for exterior locations.

PART 2 - PRODUCTS

2.1 General

- A. All fences and gates shall be purchased from UL listed manufacturers.

2.2 CHAIN-LINK FENCE FABRIC

- A. Steel Chain-Link Fence Fabric: Height indicated on Drawings. Provide fabric fabricated in one-piece widths for fencing, not less than 72 inches high with 2-inch No. 9-gage (0.1483-inch diameter) wire.

1. Zinc-Coated Fabric: Comply with ASTM A 392 Class 2 and F 1083 and FS: RR-R-191, Type I, with zinc coating applied to steel wire before weaving with the following minimum coating weight:
 - a. Not less than 1.2 oz./sq. ft. of uncoated wire surface.
2. Coat selvage ends of fabric that is metallic coated during the weaving process with manufacturer's standard clear protective coating.
3. The vinyl coating is thermally bonded to a thermoset bonding layer over a galvanized steel wire. This process ensures a tightly adherent and impervious coating free of voids, as well as a smooth and lustrous surface appearance.
4. Vinyl coating thickness, galvanized coating weight, and wire tensile strength conform to ASTM F668 Class 2b, Federal specification RR-F-191/1E Type IV, AASHTO M-181 Type IV, Class B
5. Only plasticized poly(vinyl chloride) (PVC) with a low temperature (-20 C ; -4 C) plasticizer and no extenders or extraneous matter other than the necessary stabilizers and pigments, shall be used.
6. The PVC coated wire shall pass the test for adhesion contained in ASTM F668 for Class 2b chain link fabric.

B. Selvage: Twisted and barbed finish at top and knuckled at bottom selvage.

C. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

1. Allied Tube and Conduit Corp.
2. Approved Equal.

2.3 INDUSTRIAL FENCE FRAMING

- A. Round Steel Pipe: Standard weight, Schedule 40, vinyl coated, galvanized steel pipe complying with ASTM F 1083 and RR-F-191 for Class F steel fence.
 1. External and Internal Coating Type A consisting of not less than 1.8 oz/sq. ft. zinc.
- B. SS40 pipe produced by Allied Tube shall be an acceptable alternative to SCH 40.
- C. Terminal Posts at all motorized gates: Standard weight, 4.00-inch O.D. galvanized steel pipe of material listed in this specification.
- D. Terminal Posts: Standard weight, 3.00-inch O.D. galvanized steel pipe of material listed in this specification.
- E. Line posts: Standard weight, 2.50-inch O.D. galvanized steel pipe of material listed in this specification.
- F. Post Brace Rails: Provide brace rail with truss rod assembly for each gate, end, and pull post. Provide two brace rails extending in opposing directions, each with truss rod assembly, for each corner post and for pull posts. Provide rail ends and clamps for attaching rails to posts.
 1. Minimum 1.660 inches OD pipe.
- G. Vinyl Coating: All framing and appurtenances shall:
 1. Have a Vinyl coating fused and adhered to the exterior zinc coating of the galvanized pipe in accordance with ASTM F1043.
 2. The minimum thickness of the PVC (Vinyl) coating shall be 10-mils (0.254 mm). Color to match fabric, black, per ASTM F934.

2.4 GATES, GENERAL

- A. Gates for Class F Fence: Conform to FS-RR-F-191.
- B. Gate Frame: The entire frame and support members shall be manufactured with the same aluminum material, alloy and temper 6061-T6 (ASTM 1184). Fabricate chain link cantilever slide gates in accordance with ASTM F-1184, Type II, Class 2, using 2 inch square aluminum outside vertical members (1.10 lb/ft). Members are welded together with a continuous top track (3.83 lb/ft) and bottom rail to form a rigid one piece frame. Vertical interior support uprights will be positioned equally throughout the frame structure.

Standard Opening	Overall Gate	Length Bays
15 ft. to 18 ft.	26' 3"	4
19 ft. to 22 ft.	31' 3"	5

- C. For 15 ft. – 22 ft. opening gates, the vertical interior support uprights will be 1.5 inch square aluminum (6061-T6) tubing (0.809 lb/ft). The bottom rail shall be a continuous one-piece 2 inch square aluminum (6061-T6) tube (1.10 lb/ft).

Standard Opening	Overall Gate	Length Bays
23 ft. to 26 ft.	37' 3"	6
27 ft. to 30 ft.	42' 3"	7

- D. The cantilever overhang will be 40% or greater for any given opening size.
- E. There will be two truck assemblies (secured to the guide posts) which operate inside the top track. They shall be swivel type zinc die cast with 4 sealed and lubricated ball bearing rollers (2" dia., 9/16" width) and two side rollers (front and back) to assure alignment in the top track.
- F. The top track and rail is an enclosed combination one piece aluminum (6061-T6) extrusion weighing 3.83 lb/ft. Top track to withstand a 2,000 lb. reaction load.
- G. Chain link fabric shall be installed over the entire gate length (UL-325) which will create a universal design (gate can be used for right or left hand applications). Fabric will be attached securely with tension bars that are attached on either frame end by tension bands.
- H. High tensile wire will provide additional fabric support across the top and bottom of the gate structure.
- I. Diagonal bracing shall be 1"x2" aluminum (6061-T6) tubing (0.809 lb/ft) welded to the uprights to form a rigid bracing system that does not require field adjustment.
- J. Bottom guide wheel assemblies have two 3" dia. rubber wheels (with protective covers – UL325) straddling the bottom horizontal gate rail. One assembly shall be attached to each guide post.
- K. Gate post brackets, latch, and keepers are galvanized steel.
- L. Motor Operated Gate posts shall be 4" OD schedule 40 or SS40 pipe (9.1 lb/ft). Two support posts and 1 latch post shall be installed.
- M. Primary personnel gates shall be manually operated, with provisions for "Best Lock" padlocks.
- N. Double Swing gates shall include a lockable center post socket in concrete at grade.

- O. Primary vehicle gates shall be power operated and activated by an electronic access control system. Vehicle gate shall be tied into security system in the building which will be constructed under a separate contract.
- P. Cantilever Linear Vehicle Gates shall operate at a minimum speed of two (2) feet per second.
- Q. Vehicle Gates shall be capable of opening to provide full clearance from end posts as identified in the contract drawings.
- R. Motor Operator shall be installed under this contract and capable of receiving:
 1. Control signals from ground loops and electronic eye equipment.
 2. Control signals from building security system.
 3. Control signals from future identity card swipe terminal, to be constructed under a separate contract.
 4. Control signals from fire department emergency access panel.
- S. Frames and Bracing: Fabricate from round galvanized steel tubing with outside dimension and weight according to ASTM F 1184 for the following gate fabric height:
 1. Gate fabric height by opening Width: 6 feet tall and widths as indicated on the contract drawings.

2.5 FITTINGS

- A. General: Provide fittings for a complete fence installation, including special fittings for corners. Fittings shall have coatings matching in material, color, product standards of adjoining fence fabric and framing.
- B. For steel fences, stretcher bar and tension wire bands or clamps shall be 11-gage (0.1205-inch diameter) minimum thickness galvanized pressed steel bands; ties for attaching fabric to line posts shall be equal to 6-gage (0.0162 inch diameter) galvanized steel wire; ties for attaching fabric to top and brace rails shall be equal to 9-gage (0.1483 inch diameter) galvanized steel wire; and hog rings shall be equal to 9-gage (0.143-inch diameter) galvanized steel wire, except that stretcher bar clamps, ties and hog rings may be of aluminum conforming to the requirements of FS – RR-F-191.
- C. Post and Line Caps: Hot-dip galvanized pressed steel or hot-dip galvanized cast iron. Provide weathertight closure cap for each post.
 1. Provide line post caps with loop to receive tension wire.
- D. Stretcher Bars: Fabricate one piece lengths equal to full height of fabric with a minimum cross section of 1/4-inch by 3/4-inch. Provide one stretcher bar of each gate, end post, and two for each corner or pull post.
- E. Stretcher Bar Bands: Heavy pressed steel, spaced not over 14 inches on center to secure stretcher bars to end, corner, pull and gate posts. Bands shall be within 4 inches of the top and bottom of fence fabric.
- F. Taut reinforcing wires shall be 9-gage installed and interwoven with or affixed with 9-gage fabric ties spaced uniformly between the top and bottom of the fence fabric.
- G. Tie Wires, Clips, and Fasteners: Provide the following types:
 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
 - a. Hot-Dip Galvanized Steel: Nine-gage wire; galvanized coating thickness matching coating thickness of chain-link fence fabric. Spaced at 14 inches o.c.

H. Pipe Sleeves: For posts set into concrete, provide preset hot-dip galvanized steel pipe sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch more than outside dimension of post, and flat steel plate forming bottom closure.

2.6 CAST-IN-PLACE CONCRETE

A. General: Comply with ACI 301 for cast-in-place concrete.

B. Materials: Portland cement complying with ASTM C 150, aggregates complying with ASTM C 33, and potable water.

1. Concrete Mixes: Normal-weight concrete, air entrained with not less than 4000-psi compressive strength (28 days), 3-inch slump, and 1-inch maximum size aggregate.

C. Refer to Section 03300 "Cast-In-Place Concrete."

2.7 GROUT AND ANCHORING CEMENT

A. 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.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance.

1. Do not begin installation before final grading is completed, unless otherwise permitted by OWNER.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. General: Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line, or as indicated on the Drawings.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed or compacted soil.
 1. Drill holes for post footings in firm, undisturbed or compacted soil. Holes shall have a diameter equal to 4 times the diameter of the post except where otherwise indicated on the drawings.
 2. Excavate hold depths approximately 3 inches deeper than post bottom with bottom of lineposts set not less than 48 inches in concrete base.
- C. Post Setting: Hand-excavate holes for post foundations in firm, undisturbed or compacted soil. Set terminal, line and gate operator-mounting posts in concrete footing. Protect portion of posts aboveground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Using mechanical devices to set line posts per ASTM F 567 is permitted. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during placement and finishing operations until concrete is sufficiently cured.
 1. Maximum spacing between line posts is 10 feet.
 2. Set keepers, stops, sleeves, and other accessories into concrete as required.
 3. All posts shall be able to pass a pull test when a force of 48 pounds is applied perpendicular to the fence at the top of the post. The post should not deflect more than 1 inch at the location where the force is applied.
 4. Post tops shall be riveted or shall be spot-welded. No loose or rattling fittings will be allowed.
 5. Concealed Concrete Footings: Stop footings 2 inches below grade to allow covering with surface material.

3.4 CHAIN-LINK FENCE INSTALLATION

- A. Terminal Posts: Locate terminal end, corner, and gate posts and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
- B. Post Bracing Assemblies: Install according to FS RR-F-191, maintaining plumb position and alignment of fencing. Install braces at end and gate posts and at both sides of corner and pull posts. Locate horizontal braces at two-thirds fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
 1. Anchor posts shall be set at approximately 500-foot intervals and braced to the adjacent line posts. Posts shall be braced before the wire fencing is placed.
- C. Tension Wire: Install according to FS RR-F-191, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch-diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric.
 1. Top Tension Wire: Install tension wire through post cap loops.
 2. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same gage and type of wire.
- D. Top Rail: Install according to FS RR-F-191, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended by fencing manufacturer.
- E. Brace Rails: Install in one piece at post-height center span, spanning between posts, using fittings, special offset fittings, and accessories.

- F. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave a maximum of 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- G. Tension or Stretcher Bars: Provide two stretcher bars for each pull post. Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 14 inches o.c.
- H. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts 12 inches o.c. and to braces 24 inches o.c.
- I. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side.

NOTE: All nuts for tension bands and carriage bolts shall be “tack welded” after final installation as per Owner direction and observation.

3.5 GATE INSTALLATION

- A. General: Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.6 GROUNDING

- A. Refer to Section 16452, “Grounding.”

3.7 FIELD QUALITY CONTROL

- A. Ground-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure ground resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by two-point method according to IEEE 81.
- B. Desired Maximum Grounding Resistance Value: 25 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds desired value, notify OWNER promptly. Include recommendations to reduce ground resistance and proposal to accomplish recommended work.
- D. Report: Prepare test reports, certified by testing agency, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.8 ADJUSTING

- A. Gate: Adjust gate to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

- B. Lubricate hardware, gate operator and other moving parts.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Government's personnel to adjust, operate, and maintain gates.

1. Test and adjust operators and controls hardware, and other operable components. Replace damaged or malfunctioning operable components.
2. Train Government personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
3. Review data in maintenance manuals. Refer to Section 01782, "Operation and Maintenance Data."
4. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION 323113

SECTION 323300 - SITE FURNISHINGS

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. Seating.
2. Bicycle racks.
3. Trash receptacles.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing pipe sleeves cast in concrete footings.
2. Section 312000 "Earth Moving" for excavation for installing concrete footings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 SEATING ("BENCH")

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wausau Tile Inc.; MF2201 or a comparable product by one of the following:

1. Creative Pipe, Inc.
2. Madrax; Graber Manufacturing Co.
3. Victor Stanley, Inc.

B. Frame: Galvanized steel.

C. Seat and Back:

1. Material:
 - a. Painted Steel: Evenly spaced, parallel flat straps or bars.
2. Seat Height: 16 to 17 inches.
3. Seat Surface Shape: Contoured or dished.
4. Overall Height: 39 inches.
5. Overall Width: 74 inches.
6. Overall Depth: 28 inches.
7. Arms: Two, one at each end.
 - a. Arm Material: Match frame.
8. Weight: 275 pounds.

D. Steel Finish: Powder coated.

1. Color: As selected by Architect from manufacturer's full range.

2.2 BICYCLE RACKS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wausau Tile Inc.; MF9013 or a comparable product by one of the following:

1. Creative Pipe, Inc.
2. Madrax; Graber Manufacturing Co.
3. Victor Stanley, Inc.

B. Bicycle Rack Construction:

1. Frame: Galvanized steel.
 - a. Pipe OD: Not less than 2-3/8 inches (60 mm).
2. Style: 7-loop in-ground mount.
 - a. Overall Height: 36 inches above paving.
 - b. Overall Width: 96 inches.
 - c. Capacity: Designed to accommodate no fewer than nine bicycles.
3. Installation Method: Cast in concrete.

C. Steel Finish: Color coated.

1. Color: As selected by Architect from manufacturer's full range.

2.3 TRASH RECEPTACLES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wausau Tile Inc.; MF3204 or a comparable product by one of the following:

1. Creative Pipe, Inc.
2. Victor Stanley, Inc.

- B. Steel Facing Surrounds: Evenly patterned, parallel flat steel straps, bars, or tubular shapes, to match benches.
- C. Support Frames: Galvanized steel; welded.
- D. Trash Receptacles:
 - 1. Receptacle Shape and Form: Round cylinder with tapered funnel top; with opening for depositing trash in lid or top.
 - 2. Lids and Tops: Matching facing panels secured by cable or chain, hinged, swiveled, or permanently secured.
 - a. Description: Elevated flat or shallow dome rain-cap lid.
 - 3. Receptacle Height: 51 inches.
 - 4. Overall Diameter: 26 inches.
 - 5. Weight: 200 pounds.
 - 6. Inner Container: Rigid plastic container with drain holes and lift-out handles; designed to be removable and reusable.
 - 7. Capacity: Not less than 40 gal. (151 L).
 - 8. Service Access: Fixed lid or top, side access; inner container and disposable liner lift or slide-out for emptying; self-latching hinge.
- E. Steel Finish: Color coated.
 - 1. Color: As selected by Architect from manufacturer's full range.

2.4 MATERIALS

- A. Steel and Iron: Free of 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/A 53M, or electric-resistance-welded pipe complying with ASTM A 135/A 135M.
 - 3. Tubing: Cold-formed steel tubing complying with ASTM A 500/A 500M.
 - 4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513/A 513M, or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500/A 500M; zinc coated internally and externally.
 - 5. Sheet: Commercial steel sheet complying with ASTM A 1011/A 1011M.
 - 6. Malleable-Iron Castings: ASTM A 47/A 47M, grade as recommended by fabricator for type of use intended.
 - 7. Gray-Iron Castings: ASTM A 48/A 48M, Class 200.
- B. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials; commercial quality, concealed, recessed, and capped or plugged.
- C. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M; recommended in writing by manufacturer, for exterior applications.
- D. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring,

patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.

E. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:

1. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, polymer film. Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.3 mil (0.0076 mm) thick.
2. Hot-Dip Galvanizing: According to ASTM A 123/A 123M, ASTM A 153/A 153M, or ASTM A 924/A 924M.

2.5 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. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

E. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.6 GENERAL FINISH REQUIREMENTS

A. 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.

2.7 STEEL AND GALVANIZED-STEEL FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester, 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 of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.
- D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
- E. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

END OF SECTION 323300

SECTION 329200 - TURF AND GRASSES

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. Execute the work of this Specification in accordance with applicable portions of;

1. Division 1 – General Requirements
2. Drawings L-101

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Meadow grasses and wildflowers.

B. Related Sections:

1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
3. Division 32 Section "Landscape" for plantings.

1.3 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 EXTERNAL DOCUMENTS

A. The Delaware Erosion and Sediment Control Handbook; 2005 Update. Available at <http://www.dnrec.delaware.gov>.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

1.6 INFORMATIONAL SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture to be utilized for the project. Include identification of source and name and telephone number of supplier.

B. Qualification Data: For qualified landscape Installer.

C. Product Certificates: For soil amendments and fertilizers, from manufacturer.

D. Material Test Reports: For existing in-place surface soil and imported topsoil.

E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with specialty area(s), designated CLT-Exterior.
 - b. Certified Turfgrass Professional, designated CTP.
 - c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.

5. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
6. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for turf growth.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for lime, nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Pre-installation Conference: To Be Announced

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Sod: (NOT USED).

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

1.9 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance.

1. Spring Planting: March 15 – June 15
2. Fall Planting: September 15 – November 15

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.10 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: 90 days from date of installation.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
2. Sodded Turf: (NOT USED)

B. Initial Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 90 days from date of installation.

C. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 All materials shall comply with the Delaware Erosion and Sediment Control Handbook; 2005 Update. Available at <http://www.dnrec.delaware.gov>.

2.2 TEMPORARY STABILIZATION SEED

A. Grass Seed: Mix no. 5 (annual ryegrass) in accordance with detail de-esc-3.4.3, sheet 1 of 4 within the Delaware Erosion and Sediment Control Handbook.

B. Seed Species: Annual Ryegrass. Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. All areas: Annual Ryegrass (*Lolium temulentum*).
2. Apply at 125#/acre.
3. Planting depth, 0.5 inches.

2.3 PERMANENT GRASS SEED

A. Apply mix No. 7 in accordance with DE-ESC-3.4.3, sheet 2 of 4 within the Delaware Erosion and Sediment Control Handbook.

1. All areas: Mix No. 7
2. Apply at 150#/acre.

2.4 BIOSWALE GRASS SEED

- A. Apply mix No. 4 in accordance with DE-ESC-3.4.3, sheet 2 of 4 within the Delaware Erosion and Sediment Control Handbook.
 1. All areas: Mix No. 4
 2. Apply at:
 - a. Strong Creeping Red Fescue - 100#/acre.
 - b. Kentucky Bluegrass (Blend) - 70#/acre.
 - c. Perennial Ryegrass - 15#/acre.
 - d. Redtop - 10#/acre.

2.5 MEADOW GRASSES AND WILDFLOWERS

- A. Deer Resistant Meadow Grass Seed: Fresh, clean, and dry new seed, of mixed species as follows:
 1. ERNMIX-155
 - a. All areas denoted as meadow
 - b. Apply at:
 - 1) 20lb/acre
- B. Seed Carrier: Inert material, sharp clean sand, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

2.6 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 85 percent calcium carbonate, ground so that not less 90% passes a 10 mesh sieve and not less than 30% passes a 100 mesh sieve. Apply at the rate adequate to bring pH range up to 6.0 to 6.5.
- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.
- F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.
- G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.
- H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
- I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.7 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through $\frac{1}{2}$ inch sieve; soluble salt content of 4 to 8 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.
 - B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.
 - C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

2.8 FERTILIZERS

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
 - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
 - 3. For lawns, provide fertilizer with not less than 4% phosphoric acid and not less than 2% potassium and the percentage of nitrogen required to provide not less than 1 lb. of actual nitrogen per 1000 sq. ft. of lawn area. Provide nitrogen in a form that will be available to the lawn during the initial period of growth.

2.9 PLANTING SOILS**A. TOPSOIL**

Topsoil shall be from off-site sources. It shall be without admixture of subsoil or slag and shall be free of stones, lumps, plants or their roots, sticks and extraneous matter, and shall not be moved, placed or used while in a frozen or muddy condition.

Topsoil from off-site sources shall have an acidity range of pH 5.0 to 7.0 and shall contain not less than 5% organic matter as determined by the "Walkley-Black Method" (Colorimetric version). Sufficient limestone shall be added to topsoil used to bring it to a range of pH 6.0 to pH 6.5.

Soil sample tests will be ordered by the Landscape Architect and shall be made by a state or commercial laboratory using methods approved by the Associates of Official Agricultural chemists or the State Agricultural Experiment Station.

Such analysis will be paid for by the Contractor. Moving and placing of topsoil may be made after approval of the analysis by the Landscape Architect.

If approved, natural topsoil not having the hydrogen-ion value specified above may be amended by the contractor, at his own expense, to bring it within the specified limits. Topsoil shall meet the following mechanical analysis:

	<u>Passing %</u>	<u>Retained %</u>
1" Screen	100%	0%
1/2" Screen	97-100%	0-3%
No. 100 Mesh Sieve	60-40%	40-60%

There shall be a minimum of 4" of topsoil (after settlement) in all plant beds, pit plantings, ground cover areas, and lawns or as called for on the drawings whichever is greater.

B. LIGHT WEIGHT ON-STRUCTURE PLANTING SOIL (NOT USED)

2.10 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Hardwood Bark Mulch (Shredded).
 - 1. Shredded Hardwood Bark Mulch made of various hardwoods, mostly Oak, is ground (hammer milled) through a screen to provide a shredded, fibrous material. This is coarse mulch with large pieces down to fines. The pH shall range between 6 and 7.
- C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
- D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content 2-5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content 50-60 percent of dry weight.
 - 2. Feedstock: (NOT USED).
- E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.11 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.12 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples,
- C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface,. Include manufacturer's recommended anchorage system for slope conditions.

2.13 GRASS-PAVING MATERIALS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Thoroughly blend planting soil off-site before spreading.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 - 2. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
 - b. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
 - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 - 2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
 - 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
 - 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
- C. Fill cells of erosion-control mat with planting soil and compact before planting.
- D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 1. Do not use wet seed or seed that is moldy or otherwise damaged.
 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of as noted on plans.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.
- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
 2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- G. Protect seeded areas from hot, dry weather or drying winds by applying peat mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with [fiber-mulch manufacturer's recommended tackifier].
2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than [1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate].
3. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.7 TURF RENOVATION

A. Renovate existing turf.

B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches

I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

J. Apply seed and protect with straw mulch as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.8 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

D. Turf Post fertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.9 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over and bare spots not exceeding 5 by 5 inches .
2. Satisfactory Sodded Turf: (NOT USED).

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.10 MEADOW

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at a total rate of as noted on plans.

C. Brush seed into top 1/16 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas from hot, dry weather or drying winds by applying peat or compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

E. Water newly planted areas and keep moist until meadow is established.

3.11 MEADOW MAINTENANCE

- A. Maintain and establish meadow by watering, weeding, mowing (twice year), trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water meadow with fine spray at a minimum rate of 1/2 inch per week for six week weeks after planting unless rainfall precipitation is adequate.

3.12 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.13 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

SECTION 329300 – LANDSCAPE ARCHITECTURE**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. Execute the work of this Specification in accordance with applicable portions of:

1. Division 1 - General Requirements
2. Drawings L-101, L-102

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Tree stabilization.

B. Related Sections:

1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
2. Division 32 Section "Turf and Grasses" for turf (lawn), sod (alternate to bid) and meadow planting, hydro-seeding, and erosion-control materials.
3. Division 32 Section "Unit Paving"
4. Play Equipment installation. (see Section 3.20)
5. Safety Surface for Playgrounds. (see Section 3.20)

1.3 ALLOWANCES

A. Allowances for plants are specified in Division 01 Section "Allowances."

1. Perform planting work under quantity allowances and only as authorized. Authorized work includes: Unless specifically excluded hereinafter under RELATED SECTIONS: provide labor, materials, equipment and services necessary and incidental to complete work described by this Section's title shown above. Work includes, but is not necessarily limited to:
 - a. Fine Grading.
 - b. Providing and Placing all Off-site Topsoil and Planting Soil Backfill Mix required to complete Landscape Development Work.

- c. Preparation of Planting Areas as required.
- d. Furnishing and installing all Plant Material.
- e. Furnishing and installing all Shredded Hardwood Bark Mulch
- f. Furnish and install playground poured in place safety surface.
- g. Furnish and install playground tile safety surface (swing area only)
- h. Furnish and install playground equipment.
- i. Maintenance of all Work until Final Acceptance (not less than 60 days).
- j. Clean-up of Work Area as outlined in these specifications.

- 2. Notify Landscape Architect weekly of extent of work performed that is attributable to quantity allowances.
- 3. Perform work that exceeds quantity allowances only as authorized by Change Orders.

B. Work By Others;

- 1. Installation of Bituminous Parking Lots and Drives.
- 2. Installation of Curbs, Concrete Walks and Wheel Stops.
- 3. New School Building.
- 4. Site Furniture, Flag Poles

1.4 UNIT PRICES**A. Work of this Section is affected by unit prices specified in Division 01 Section "Unit Prices."**

- 1. Unit prices apply to authorized work covered by quantity allowances.
- 2. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

1.5 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B **Balled and Burlapped Stock:** Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. **Balled and Potted Stock:** Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. **Bare-Root Stock:** Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.

- E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- F. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
- H. Finish Grade: Elevation of finished surface of planting soil.
- I. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- J. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- K. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- L. Planting Area: Areas to be planted.
- M. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- N. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- O. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- P. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- Q. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- R. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- S. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, including soils.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 - 2. Pesticides and Herbicides: Include product label and manufacturer's application instruction specific to the Project.
 - 3. Plant Photographs: Include color photographs in either digital or 3- by 5-inch (76- by 127-mm) print format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 10 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
- B. Samples for Verification: For each of the following:
 - 1. Trees and Shrubs: Contact Landscape Architect for review of plant material, based on information received above in product data. The Landscape Architect reserves the right to inspect trees and shrubs either at place of growth or at site before planting, for compliance with requirements for name, variety, size and quality. Provide trees and shrubs grown in a recognized nursery in accordance with good horticultural practice. Provide healthy, vigorous stock grown under climatic conditions similar to conditions in the locality of the project and free of disease, insects, eggs, larvae, and defects such as knots, sunscald, injuries, abrasions or disfigurement. Provide trees and shrubs of the sizes shown as specified. Trees and shrubs of larger size may be used, if acceptable to Landscape Architect, and if sizes of roots or balls are increased proportionately.
 - 2. Mulch: one quart volume of each organic mulch required, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
 - 3. Filter Fabric: 12 x12" sample, with manufacturer specifications.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualifications: The Landscape Work shall be done by a single firm specializing in landscaping work. Include list of similar projects completed, demonstration Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - 1. General: Ship landscape materials with certificates of inspection as required by governmental authorities. Comply with governing regulation applicable to landscape materials.
 - 2. Manufacturer's certified analysis of standard products.
 - 3. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Material Test Reports:

1. Certification: For information only, submit 2 copies of certificates of inspection as required by governmental authorities, and manufacturers or vendor's certified analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.
- D. Maintenance Instructions: Maintenance Instructions: Submit two copies of typewritten instructions recommending procedures to be established by the Owner for the maintenance of landscape work for one full year. Submit prior to expiration of required maintenance period(s).
- E. Provide two copies of warranty (See Item 1.11 for specific requirements).
- F. Schedule of Work: For information only, submit 3 copies of tentative schedule to Owner and/or Owner's Agent along with Landscape Architect. Contractor shall keep all parties above apprised of any changes so that the Owner's Agent is aware of scheduled work at least 24 hours prior to said work being started.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Provide Professional Memberships.
 2. Provide number of years' experience in Landscape Installation in addition to requirements in Division 01 Section "Quality Requirements"
 3. Provide Field Supervision Installers experience. Note full-time Supervisor to be on Project Site at all times when landscape installation is in progress.
 4. Pesticide Applicator: Licensed
- B. Provide Soil-Testing Laboratory Name and Qualifications.
- C. Soil Analysis: For each un-amended soil type, furnish soil analysis and a written report by a qualified soil testing laboratory stating percentages of organic matter, gradation of sand, silt, and clay content; cation exchange capacity, deleterious material, pH, and mineral and plant nutrient content of the soil.
 1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Landscape Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 3. Report suitability of tested soil for plant growth.
 - a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq ft or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- D. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1. Do not make substitutions: If specified landscape material is not obtainable, submit to Landscape Architect proof of non-availability and proposal for use of equivalent material. When authorized, adjustment of contract amount will be made.

E. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Landscape Architect of sources of planting materials 14 days in advance of delivery to site.

F. Hardscape Materials: Materials and methods of construction shall comply with American Society for Testing and Materials (ASTM). Installation shall be performed by skilled workmen with a satisfactory record of performance on completed projects of comparable size and quality. Do not change source of Hardscape Materials during the course of the work.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable. Protect materials from deterioration during delivery, and while stored at the site. Materials shall be checked to ensure that no damages occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage and to protect against damage, weather, vandalism and theft.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, and soil amendments with appropriate certificates.

C. Plant Materials:

1. Bare- Root Stock: NOT USED.
2. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
3. Label at least one tree and one shrub of each variety with a securely attached waterproof tag bearing legible designation of botanical and common name.
4. Do not remove container grown stock from containers until planting time.
5. Handle planting stock by root ball.
6. Bulbs: NOT USED
7. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six (6) hours after delivery, set plants and trees in their appropriate conditions, protect from weather and mechanical damage, and keep roots moist.
 - a. Set balled stock on ground and cover ball with soil, peat moss, or other acceptable material.
 - b. Do not remove container-grown stock from containers before time of planting.

c. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary, to maintain root systems in a moist, but not overly-wet condition.

1.10 PROJECT CONDITIONS

A. Field Measurements: Installer must verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work. Installer must observe the conditions under which work is to be performed, and notify the Landscape Architect of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify the Landscape Architect/ Construction Manager and or Owner no fewer seven days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Construction Managers and or Owner's written permission.

C. Planting Restrictions: Proceed with and complete the landscape work as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

D. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Landscape Architect before planting.

E. Planting Schedule: Prepare a proposed planting schedule. Schedule the dates for each type of landscape work during normal seasons for such work in the area of the site. Correlate with specified maintenance periods to provide maintenance until acceptance by the Owner. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.

F. Coordination with Lawns: Plant trees and shrubs after final grades are established and prior to planting of lawns, unless otherwise acceptable to the Landscape Architect. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

G. Protect existing trees, shrubs and other hardscape elements against damage including trespassing, and erosion.

H. Protect all existing plant material in the area of this contract, whether inside or outside the contract limit line, against any damage, which in the opinion of the Landscape Architect will cause death or major retardation. Such material shall be replaced with same size and species by the Contractor at no additional cost should such damage occur.

I. Inspection of work will be made at the conclusion of work (at acceptance of the project). Submit written notice requesting final inspection at least 10 days prior to anticipated date.

1.11 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

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

- a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond contractor's control.
- b. Structural failures including plantings, falling or blowing over.
- c. Structural failures of tree stabilization structures, or stone energy dissipaters

2. Warranty periods will begin from the Date of installation completion (as determined by the Landscape Architect for a period of 12 months (one year).
3. Include the following remedial actions as a minimum.
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement for each plant will be required except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for a period equal to the original warranty period, for replaced plant material.

1.12 MAINTENANCE

- A. All planted trees, shrubs, groundcovers and annual flowers, shall be maintained until final acceptance of the completed contract. This shall be not less than 60 days. Maintenance shall include watering, cultivating, control of insects, fungus, and other horticultural operations necessary for the proper growth of all plants.

** END OF PART 1 **

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings L-101. and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders (unless otherwise indicated); tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; or with stem girdling roots will be rejected.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 "Standard for Nursery Stock" for types and form of plants required. Plants of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls. Provide plant materials true to name and variety established by the American Joint Committee on Horticultural Nomenclature "Standardized Plant Names," Second Edition, 1942.

C. Deciduous Trees: Provide trees of height and caliper listed or shown and with branching configuration recommended by ANSI Z60.1 for type and species required. Provide single stem trees except where special forms are shown or listed.

1. Provide balled and burlapped (B&B) deciduous trees.
2. Container grown deciduous trees will be acceptable in lieu of balled and burlapped deciduous trees subject to specified limitations of ANSI Z60.1 for container stock.

D. Deciduous Shrubs: Provide shrubs of the height shown or listed and with not less than the minimum number of canes required by ANSI 260.1 for the type and height of shrub required.

1. Provide balled and burlapped (B&B), bare root (B.R.) or container deciduous shrubs as specified in plant list.
2. Container grown deciduous shrubs will be acceptable in lieu of balled and burlapped deciduous shrubs subject to the specified limitations for container grown stock.

E. Coniferous and Broadleaved Evergreens: Provide evergreens of the sizes shown or listed. Dimensions indicate minimum spread for spreading and semi-spreading type evergreens and height for other types, such as globe, dwarf cone, pyramidal, broad upright and columnar. Provide normal quality evergreens with well-balanced form complying with requirements for other size relationships to the primary dimension shown.

1. Provide balled and burlapped (B&B) or container grown evergreens as specified.
2. Container grown evergreens will be acceptable in lieu of balled and burlapped evergreens subject to the specified limitations for container grown stock.

F. Labeling: label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

G. If formal arrangements or consecutive order of plants is shown on plans, select stock for uniform height and spread, and number the labels to assure symmetry in planting

H. Annuals and Biennials – Optional for Client determination. Provide healthy, disease-free plants, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

2.2 INORGANIC SOIL AMENDMENTS

- A. Ground Limestone: (To be incorporated into soil if soil pH value test shows low level of soil Ph which needs to be raised.). ASTM C 602, natural limestone containing not less than 85% of total carbonates, ground so that not less 90% passes a 10 mesh sieve and not less than 30% passes a 100 mesh sieve. Apply at the rate adequate to bring pH range up to 6.0 to 6.5.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No.6 sieve and a maximum of 10 percent passing through no. 40 sieve.
- C. Iron Sulphate: Granulated ferrous sulfate containing a minimum of 20 percent and 10 percent sulfur. (To be incorporated into soil if soil pH value test shows high level of soil pH which needs to be lowered.) Iron Sulphate shall be applied at the rate adequate to bring pH range down to 6.0 to 6.5 and as per "Cornell Recommendations for Commercial Turf Grass Management".
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.
- F. Agricultural gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.
- G. Sand: Clean , washed, natural or manufactured, and free of toxic materials.
- H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
- I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2 inch sieve; soluble salt content of 4 to 8 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight
 - 2. Feedstock: NOT USED
- B. Peat Humus: FS Q-P-166 and with the texture and pH range OF 3.4 TO 4.8.
- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

- D. Wood Derivatives: NOT USED
- E. Manure: NOT USED

2.4 **FERTILIZERS**

- A. Bonemeal: Commercial, raw, or steamed, finely ground; 4% nitrogen and 20% phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, Soluble; a minimum of 20% available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium.

1. For All New Trees and Shrubs:

All trees and shrubs shall be fertilized with a controlled release 16-8-16 analysis fertilizer contained in a polyethylene perforated bag with micropore holes. The bag shall contain four (4) ounces minimum of water soluble fertilizer so as to be effective for eight (8) years.

The packets shall be placed equidistantly within the planting pit adjacent to the ball or root mass, but not in direct contact with roots. Placement depth shall be 6 to 8 inches. Packets shall not be cut, ripped or damaged. If it becomes necessary to remove and replace dead or unhealthy plants, damaged or broken packets shall be replaced with new packets.

A "Certificate of Compliance" must accompany invoice showing quantity of material ordered, where material was supplied and shipped to, and its consigned route and specific job application.
2. For lawns, provide fertilizer with not less than 4% phosphoric acid and not less than 2% potassium and the percentage of nitrogen required to provide not less than 1 lb. of actual nitrogen per 1000 sq. ft. of lawn area. Provide nitrogen in a form that will be available to the lawn during the initial period of growth.

D. Organic Fertilizer and Soil Conditioner: All trees and shrubs shall be treated with PHC Healthy Start which contains a blend of natural organic nutrients, proteins, sugars and other carbohydrates, humic acids, biostimulants and beneficial bacteria that enrich soil.

PHC Healthy Start is available from Plant Health Care, Inc., 440 William Pitt Way, Pittsburgh, Pennsylvania, 1-800-421-9051. (Or approved equal)

2.5 **PLANTING SOILS**

A. **TOPSOIL**

Topsoil shall be from off-site sources. It shall be without admixture of subsoil or slag and shall be free of stones, lumps, plants or their roots, sticks and extraneous matter, and shall not be moved, placed or used while in a frozen or muddy condition.

Topsoil from off-site sources shall have an acidity range of pH 5.0 to 7.0 and shall contain not less than 5% organic matter as determined by the "Walkley-Black Method" (Colorimetric version). Sufficient limestone shall be added to topsoil used to bring it to a range of pH 6.0 to pH 6.5.

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Soil sample tests will be ordered by the Landscape Contractor and shall be made by a state or commercial laboratory using methods approved by the Associates of Official Agricultural chemists or the State Agricultural Experiment Station.

Such analysis will be paid for by the Contractor. Moving and placing of topsoil may be made after approval of the analysis by the Landscape Architect.

If approved, natural topsoil not having the hydrogen-ion value specified above may be amended by the contractor, at his own expense, to bring it within the specified limits. Topsoil shall meet the following mechanical analysis:

	<u>Passing %</u>	<u>Retained %</u>
1" Screen	100%	0%
1/2" Screen	97-100%	0-3%
No. 100 Mesh Sieve	60-40%	40-60%

There shall be a minimum of 4" of topsoil (after settlement) in all plant beds, pit plantings, ground cover areas, and lawns or as called for on the drawings whichever is greater. 12" for annual plant beds.

B. Fill - NOT USED

C. Lightweight Or Structure Planting Soil – NOT USED

2.6 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of the following:

1. Mulch: Shall be 100% Double Hammered Milled Shredded Hardwood Bark Mulch. Mulch shall be free from any extraneous materials, and spread to a 3" depth minimum (after settlement). Contractor shall submit certification detailing content and source of mulch for Landscape Architect's approval.

2. Color: No artificial, dyes or colorant will be allowed.

B. Compost Mulch: NOT USED

2.7 WEED-CONTROL BARRIERS – NOT USED**2.8 PESTICIDES**

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.9 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

LANDSCAPE ARCHITECTURE**329300-13**

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1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, treated softwood with specified wood pressure-preserved treatment, free of knots, holes, cross grain, and other defects, (2" by 2" by 5'-0" min), pointed at one end, 3 per tree.
2. Wood Deadmen: NOT USED
3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 12 gauge.
4. Guy Cables: Five-strand, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 6 inches long, with two 3/8 inch galvanized eyebolts.

B. Root-Ball Stabilization Materials: NOT USED

2.10 LANDSCAPE EDGINGS – NOT USED

2.11 TREE GRATES – NOT USED

2.12 MISCELLANEOUS LANDSCAPE MATERIALS

- A. Anti-Desiccant: Emulsion type, film-forming agent similar to Dowax by Dow Chemical Co., or Wilt-Pruf by Nursery Specialty Products, Inc., designed to permit transpiration, but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accordance with manufacturer's instructions. All plants shall be sprayed with an anti-desiccant once in late Fall (November) and once in late Winter (February).
- B. Wrapping: Tree-wrap tape not less than 4" wide, designed to prevent borer damage and winter freezing.
- C. Filter Fabric: Filter weave 40/10 as manufactured by Nicolon/Mirafi Group. (Or approved equal). Filter weave 40/10 is available from Ragen Associates, 20 Larsen Rd., Iselin, NJ 08830, (732)602-9500 or (800)752-1010 outside NJ.
- D. Playground Equipment complying with project requirements shall be manufactured by DuraMax Structures a Playcore Company, 401 Chestnut Street, Chattanooga, TN 37402 or approved equal. (see Section 3.20).
- E. Safety surface shall be No Fault Safety Surface as manufactured by No Fault Sport Group, LLC, 3112 Valley Creek Drive, Suite 2, Baton Rouge, LA 70808. (see Section 3.20). (Or approved equal)
- F. No Fault Safety Tiles as are manufactured by ECORE International and sold exclusively by No Fault Sport Group, LLC and it's authorized agents, 1-866-637-7678 or www.nofault.com. Any substitutions must be approved. (see Section 3.20)

** END OF PART 2 **

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 1. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again two weeks after planting.
- E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING AREA ESTABLISHMENT

- A. Rough grade will be left 4" below finished grade by others. Loosen subgrade of lawn areas to a minimum depth of 4". Remove stones over 1" in any dimension and sticks, roots, rubbish and other extraneous matter and legally dispose of them off Owner's property. Limit preparation to areas, which will be planted promptly after preparation.
 1. Spread topsoil to minimum depth required to meet lines, grades and elevations shown, after light rolling and natural settlement (4" after settlement). Place approximately 1/2 of total amount of topsoil required. Work into top of loosened subgrade to create a transition layer and then place remains of topsoil. Add specified soil amendments (as per Section 3.19-B of this specification) and mix thoroughly into the upper 4 inches of topsoil.

2. Where final grades are not indicated, finish grades shall be of uniform level or slope between points for which elevations are given or from such points to existing grades, except that tops and bottoms of banks shall be rounded. Subgrade elevations shall be understood to be the specified depth below finished grades.
3. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before seeding. Do not create a muddy soil condition.
4. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45 degree angle. Excavations with vertical sides are not acceptable. Leave center bottom of excavation slightly raised at center to provide proper drainage. Ensure that root ball will sit on undisturbed base soil to prevent settling. Loosen hard subsoil in bottom of excavation.

1. For balled and burlapped (B&B) trees and shrubs, make excavations at least the equivalent of two and a half times as wide as the ball radius and equal to the ball depth, plus the following allowance for setting of ball on a layer of compacted backfill: Allow for 6" setting layer of planting soil mixture.
2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
3. Do not excavate deeper than the depth of the root ball, measured from the root flare to the bottom of the root ball.
4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
5. Maintain required angles of repose of adjacent material as show on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
6. Maintain supervision of excavations during working hours.
7. Keep excavations covered or otherwise protected after working hours, overnight and when unattended by contractor's personnel.

B. Subsoil and topsoil removed from excavations MAY NOT be used as planting soil.

C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINEPLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the tip-most root emerges from the trunk. After soil removal to expose the root flare, verify that the root ball still meets size requirements.

- B. Remove stem girdling roots and kinked roots, Remove injured roots by cutting cleanly; do not break.
- C. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 3 inches above adjacent finished grade.
- 1. During the placement of backfill place "Unique Fertilizer Packets" as specified in section 2.4 C as follows:

	<u>Types of Plants</u>	<u>No. of Packets</u>
a.	Trees:	
	Over 4 inch caliper	4
	1 to 4 inch caliper	3
	Over 6 feet high	4
	3 to 6 feet high	3
	15 to 36 inches high	2
	Under 15 inches high	1
b.	Shrubs:	
	Over 3 feet high	3
	2 to 3 feet high	2
	Under 2 feet high	1

The packets shall be placed equidistantly within the planting pit adjacent to the ball or root mass, but not in direct contact with roots. Placement depth shall be 6 to 8 inches. Packets shall not be cut, ripped or damaged. If it becomes necessary to remove and replace dead or unhealthy plants, damaged or broken packets shall be replaced with new packets.

- 2. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing final layer of backfill. Remove collar ropes only. Retain burlap on balls.
- D. Set bare root stock on cushion of planting soil mixture. Spread roots, then carefully work backfill around roots by hand and puddle with water until backfill layers are completely saturated. Plumb before backfilling and maintain plumb while working backfill around roots and placing layers above roots. Set collar 1" to 2" above adjacent finish landscape grades. Spread cut roots without tangling or turning up to surface. Cut injured roots clean, do not break.
- E. Set container grown stock as specified for balled and burlapped stock, except cut cans on two sides with an approved can cutter; remove bottoms of wooden boxes after partial backfilling so as not to damage root balls.
- F. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope: the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.
- G. Dish top of backfill to allow for mulching. For Spring planting, provide additional backfill berm around edge of excavations to form shallow saucer to collect water.
 - 1. Note: Surface of all Shrub Beds shall be crowned or sloped as required to achieve a 3% minimum surface pitch and insure positive surface drainage.

H. Wrap tree trunks of 2" caliper and larger. Start at ground and cover trunk to height of first branches and securely attach. Inspect tree trunks for injury, improper pruning and insect infestation and take corrective measures required before wrapping.

3.6 MECHANIZED TREE SPADE PLANTING – NOT USED**3.7 TREE, SHRUB, AND VINE PRUNING**

- A. Remove only dead, dying, or broken branches, Do not prune for shape.
- B. Prune, thin out and shape trees and shrubs in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed by the Landscape Architect, do not cut tree leaders, and remove only injured or dead branches from flowering trees, if any. Prune shrubs to retain natural character and accomplish their use in the landscape design. Required shrub sizes are the size after pruning.
 1. Remove and replace excessively pruned or misformed stock resulting from improper pruning.
 2. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

- A. Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend to the dimension shown on Drawings. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Use two stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper; three stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.9 ROOT-BARRIER INSTALLATION – NOT USED**3.10 PLANTING IN PLANTERS - NOT USED****3.11 GROUND COVER AND PLANT PLANTING – NOT USED****3.12 PLANTING AREA MULCHING**

- A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and tree like shrubs in Turf Areas: Apply mulch ring of 3inch thick with 36 inch radius around trunks or stems. Do not place mulch within six inches of trunk or stems
2. Organic Mulch in Planting Areas: Apply three inches thickness of organic mulch or stone extending 12 inches beyond edge of individual planting pit or trench and over whole surface of plating area, and finish level with adjacent finished grades. Do not place mulch within three inches of trunks or stems.
3. Mineral Mulch in Planting Areas: Apply 3 inch average thickness of mineral mulch over whole surface area as shown on plans, and finish level with adjacent finish grades. Do not place mulch within 6 inches of trunks or stems.

3.13 EDGING INSTALLATION

- A. Shovel-cut Edging. Separate mulched areas from turf areas with a 45 degree 4 to 6 inch deep, shovel cut edge.

3.14 TREE GRATE INSTALLATION – NOT USED**3.15 PLANT MAINTENANCE**

- A. Begin maintenance immediately after planting. Maintain trees, shrubs and other plants until final acceptance, but in no case less than the following period: 60 days after planting.
- B. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- C. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- D. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
- E. Submit two copies of typewritten instructions recommending procedures to be established by the Owner for the maintenance of landscape work for one full year. Submit prior to the expiration of required maintenance period(s).

3.16 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.17 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. During landscape installation, store materials and equipment where directed.
- B. Protect landscape work and material from damage due to landscape operations, operations of other contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.
- C. After installation and before final inspection, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

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3.18 **DISPOSAL**

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A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

3.19 PREPARATION OF PLANTING SOIL

A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps and other extraneous materials harmful or toxic to plant growth.

B. Mix specified soil amendments at required rates (derived from Topsoil Analysis Report). Also include the following:

1. For Trees and Shrubs (excluding coniferous ground cover): PHC Healthy Start 3-4-3 organic fertilizer/soil conditioner, shall be applied at 1/2 lb. per trunk diameter (cal.) inch for trees.

For shrubs as follows:

<u>Plant Size</u>	<u>Rate Cups</u>	<u>Lbs.</u>	<u># Plant Bag</u>
1 Gallon	1/2	1/4	100
5 Gallon	1	1/2	50
15 Gallon	2	1	25
24" Ball/Box	3	1 1/2	16
36" Ball/Box	5	2 1/2	10
42" Ball/Box	6	3	8
54" Ball/Box	8	4	6
72" Ball/Box	10	5	5

C. Planting Soil Mixture: Shall consist of one part off-site topsoil, as required, one part clean coarse builder's sand and one part humus. These shall be thoroughly mixed prior to any planting operations. The preceding shall be mixed with the soil amendments in Section 3.19 B.

D. Lightweight Soil Mixture: (NOT USED)

E. For pit and trench type planting, mix planting soil prior to back filling and/or placing stockpile at the site.

F. For planting beds, mix planting soil either prior to planting or apply on surface of topsoil and mix thoroughly before planting.

3.20 MISCELLANEOUS LANDSCAPE CONSTRUCTION

A. PLASTIC EDGING: Plastic Edging shall be placed as necessary as per Manufacturer's instructions. Contractor shall assemble to the lines and elevations indicated.

B. PLAY EQUIPMENT: Playground Equipment complying with project requirements shall be manufactured by Landscape Structures, 601 7th Street South, Delano, MN 55328 or approved equal. Equipment shall be as follows.

1. Swingset: #177332 5" diameter steel frame with 5" diameter steel support beam accommodating 2 swings per bay.
 - a. Expand set with three (3) additional bays, model #177333 for total of 8 seats.
 - b. Seats shall be #174018 belt seat with proguard chain

- c. Owner to select color
- d. Or approved equal

2. Log crawl tunnel #173594. Precast concrete hand painted log tunnel, hollowed log look to blend into natural environment, with peeled bark appearance and realistic texture. Or Approved Equal
3. Log Balance Beam #173596 Precast concrete hand painted log balance beam, with split beam offering choice of difficulty. Half log, peeled bark appearance to blend into the natural environment. Or Approved Equal
4. PlayBooster Structure with following accessories:
 - a. 111345A Bridge/Ramp Transition Bracket
 - b. 156070A Pinnacle Ext Deck
 - c. 156066A The Pinnacle
 - d. 229829B Chimney Climber
 - e. 122570D Cliff Climber
 - f. 152907B Deck Link w/ Barriers
 - g. 122913B Snake Climber
 - h. 145624D Vertical Ascent
 - i. 152911A Curved Transfer
 - j. 121948A Kick Plate
 - k. 111229A Square Deck Extension
 - l. 111228A Square Tenderdeck
 - m. 111231A Triangular Tenderdeck
 - n. 120314A Wire Barrier
 - o. 111357A Chinning Bar
 - p. 120902A Handhold Leglift
 - q. 111357B Turning Bar
 - r. 142890A Horizontal Ladder
 - s. 141886 Access/Landing
 - t. 211190D Treehouse Roof
 - u. 124863F SlideWinder2 Slide
 - v. Or Approved Equal
5. Embankment Slide #124863G SlideWinder2 96" Slide, installed in 60"high mounded embankment with 30" ADS DoubleWall drain pipe as tunnel running perpendicular to slide direction. Prepare slide approach slope at a maximum of 3:1 slope. Install 6" treated round posts sanded smooth at 60" o.c. +/-.
6. Wood Grain Bench: #186583 Cedar / Mink colored Recycled, wood-grain polyethylene bench 94" length. Direct Bury.
7. Wood Grain Trash Receptacle: #18658 Cedar / Mink colored Recycled, wood-grain polyethylene trash receptacle 32 gallon liner. Direct Bury.

All products, equipment and installation shall meet the standards of U.S. Consumer Products Safety Commission, Handbook for Public Playground Safety and ASTM 1487-07a-e1 Standards. All manufacturers' product data shall indicate compliance with these requirements. Storage, handling and installation shall comply with manufacturer's written instructions. Instructions are to be furnished to the client and project manager.

C. SAFETY SURFACE: Spread WoodCarpet® to a minimum depth of 8 inches after compaction. To make WoodCarpet® accessible, install WoodCarpet® in 6 in. maximum layers. Rake level, wet, and mechanically compact each layer twice with a flat surface compactor. Change direction 90 degrees on second compaction. Exercise caution to prevent damaging the geotextile fabric and drain materials. Do not operate equipment directly on the geotextile fabric.
Install TuffMats® in each kick-out area. Zeager recommends installing wear mats on top of WoodCarpet® surface to keep surface accessible. Do this by digging a channel around the mat edge down to base of the WoodCarpet® and slope mat edges down into the channel. Install anchors and nylon cable ties to attach the mat to the anchors. Refill the channel with WoodCarpet and compact.

1. Engineered Wood Fiber Playground Surfacing: WOODCARPET®
 - a. Composition: Woodcarpet contains 100% pre-consumer recovered wood.
 - b. Dimensions: Randomly sized wood fibers.
 - c. Sieve Analysis, ASTM F2075: Meets criteria.
 - d. Hazardous metal, ASTM F2075: Meets criteria.
 - e. Tramp metal, ASTM F2075: Meets criteria.
 - f. Impact, ASTM F1292: 8 inches meets criteria up to 8 foot fall height and 12 inches meets criteria up to 12 foot fall height.
 - g. Accessibility, ASTM F1951-14: Meets criteria.
 - h. Resistance to Flammability, 16 FR Part 1630 Standard for Surface. Flammability of Carpets and Rugs (FFI-70), Modified Procedure. Not Oven Dried: Meets Criteria.
 - i. Flammability, 16 CFR 1500.44, Federal Hazardous Substances Act Title 16, Chapter II, Subchapter C for Rigid and Pliable Solids: Did not ignite.
 - j. IPEMA Certification to F1292: 8 inch thickness rated to 8ft. and 12 inches rated to 12 ft. 10" over 1" Duradrain rated to 12ft.
 - k. IPEMA Certification to F2075: Tramp metal, sieve analysis & heavy metals.
 - l. Or approved equal.
2. Fabric: DURALINER®
 - a. Composition: Spunbonded polyester fabric.
 - b. Recycled content: 10% post-consumer and 10% or more of preconsumer (post manufacturing).
 - c. Size: 5 feet wide x 250 feet long.
 - d. Weight, ASTM D3776: Min. 3.24 ounces per square yard
 - e. Grab Tensile Strength: ASTM D4632: min. 81/79 pounds.
 - f. Elongation: 59/63%
 - g. Mullen Burst Strength, ASTM D3786: min. 130 pounds.
 - h. Puncture Resistance, ASTM D4833: min. 45.1 pounds.
 - i. Trapezoid Tearing Strength, ASTM D4533: min. 42/71 pounds.
 - j. Permittivity, ASTM D4491: min. 2.09 sec-1.
 - k. Flow Rate, ASTM D4491: min. 300 gal/ft/min
 - l. Or approved equal.
3. Playground Surfacing Wear Mat: WOODCARPET® FOAM MAT.
 - a. Composition: Closed-cell, cross-linked, polyethylene foam.
 - b. Recycled content: 100% pre-consumer recovered foam.
 - c. Top surface: Covered with layer of heavy duty vinyl.
 - d. Drain holes: 3/8 diameter holes, one per square foot.
 - e. Size including flaps: 44" x 44" [slide exit], 44". x 74" [swing], 86"x86" [tire swing/spinner], 86"x102"[swing bay].
 - f. Finished size: 32in.x32in. [slide exit], 32inx62in. [swing], 72"x72" tire swing/spinner toy, 72"x88" swing bay, custom sizes available.
 - g. Weight: 1.13" thick = 1.1 pounds per square foot.

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- h. Impact, ASTM F1292: 1.13 in. thick mat meets criteria up to 3 feet.
- i. IPEMA Certification: 1.13" thick mat over 11" of Woodcarpet rated to 12ft. fall protection.
- j. Custom mat vinyl specifications;
 - Color : Tan
 - Thickness: .075" or 75 mil. +/- .005
 - Material : 100% polyvinyl - Asbestos and Lead free
 - Technical data: ASTM F1913 Type 1; Grade 1
 - Flammability - GM 9070P - DNI (did not ignite)
 - Tensile, PSI : 2900 / D-638
 - Brittle point : -20C / -4F
 - Chemical resistance: ASTM F925 - No change
 - Flexibility : ASTM F-137 - PASS
 - Abrasion resistance: ASTM D3389 - Net weight loss after 1,000 revolutions: .32% - PASS
- k. Or approved equal.

** END OF PART 3 **
END OF SECTION

SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

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. Grout.
2. Flowable fill.
3. Piped utility demolition.

1.3 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

PART 2 - PRODUCTS

2.1 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.2 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.

1. Cement: ASTM C 150, Type I, portland.
2. Density: 115- to 145-lb/cu. ft..
3. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse.
4. Water: Comply with ASTM C 94/C 94M.
5. Strength: 100 to 200 psig at 28 days.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 GROUTING

- A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 330500

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

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 gravity-flow, nonpressure storm drainage outside the building, with the following components:

1. Precast concrete manholes
2. Precast concrete structures.
3. Manufactured PVC structures.
4. Storm drain pipe and appurtenances.

- B. This section includes all site stormwater drainage infrastructure up to and including the dissimilar materials adapter at building edge as shown in the contract drawings.

- C. Contractor to coordinate installation of building roof drainage downspout and cast iron boot installation with identified contractor for Bid Pack 2.

1.3 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water. Pipe joints shall be at least silttight, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For the following:

1. Storm drain pipe.

- B. Shop Drawings: For the following:

1. Manholes: Include plans, elevations, sections, details, and frames and covers.
2. Catch Basins and Stormwater Inlets. Include plans, elevations, sections, details, and frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames and covers, design calculations, and concrete design-mix report.

- C. Field quality-control test reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect pipe, pipe fittings, and seals from dirt and damage.
- B. Handle manholes according to manufacturer's written rigging instructions.
- C. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.
- D. Handle downspout boots according to manufacturer's written instructions.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Construction Manager Owner no fewer than five days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Construction Manager's written permission.
- B. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that Storm Drainage System piping may be installed in compliance with original design and referenced standards.
 - 1. Locate existing Storm Drainage System piping and structures that are to be abandoned and closed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below 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.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.3 PE PIPE AND FITTINGS

- A. Corrugated PE Drainage Pipe and Fittings NPS 48 and Smaller: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
 - 1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
 - 2. Corrugated PE Pipe and Fittings NPS 12 to NPS 48: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
 - 3. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
- B. Corrugated PE Pipe and Fittings NPS 56 and NPS 60: AASHTO MP7, Type S, with smooth waterway for coupling joints.
 - 1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

- C. Pipe shall be manufactured by ADS, Inc. or approved equal.

2.4 REINFORCED CONCRETE PIPE:

- 1. Materials shall be in accordance with ASSHTO M-170.

2. Pipe class shall be Class III unless otherwise indicated on the drawings.
3. Joints to be tongue and groove.
4. Joining material may be either:
 - a. Portland cement mortar consisting of 1 part Portland cement, 2 parts sand and enough water to provide a workable mix, or
 - b. Bitumastic joint filler equal to Ram-Neck.
5. Joints shall be watertight under full flow conditions.

2.5 NONPRESSURE-TYPE PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 1. For Concrete Pipes: **ASTM C 443**, rubber.
 2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

2.6 MANHOLES

- A. Precast Concrete Manholes: ASTM C 478, precast reinforced concrete, of depth indicated with provision for rubber gasket joints.
 1. Base Section: 8-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and having a separate base slab or base section with integral floor.
 2. Riser Sections: 5-inch minimum thickness; 48-inch diameter, and lengths to provide depth indicated.
 3. Top Section: Eccentric cone type, unless concentric cone or flat-slab-top type is indicated. Top of cone to match grade rings.
 4. Grade Rings: Provide 2 or 3 reinforced concrete rings, with 12 maximum inches total thickness and match 24-inch diameter frame and cover.
 5. Gaskets: ASTM C 443, rubber.
 6. Steps: Cast into base, riser, and top sections sidewall at 12-to 16-inch intervals.
 7. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
 8. Channel and Bench: Concrete or Brick.
 9. Coat Exterior Surface with two (2) coats of coal-tar epoxy, 15 mil. Minimum thickness.
- B. Manhole Steps: Wide enough for a man to place both feet on one step and designed to prevent lateral slippage off the step.
 1. Material: Steel-reinforced plastic.
 2. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, heavy-duty, ductile iron, 24-inch inside diameter by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch-diameter cover, indented top design, with lettering "STORMDRAIN" cast into cover.

2.7 CATCH BASINS & INLETS

- A. Standard Precast Concrete Catch Basins & inlets: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

1. Catch basins & inlets shall be according to the local utility standard as noted on the structure schedule.
2. All materials for catch basins, steps, frames and grates, curb inlets and other appurtenances and incidentals shall conform to Sections 708 of the DelDOT specifications.

B. PVC Plastic Catch Basins and inlets: Engineered, watertight, manufactured pvc bodies with ductile iron grates.

1. The ductile iron grates for each of these fittings are to be considered an integral part of the surface drainage inlet and shall be furnished by the same manufacturer.
2. The surface drainage inlets shall be as manufactured by Nyloplast a division of Advanced Drainage Systems, Inc., or prior approved equal.
3. The drain basins required for this contract shall be manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454.
4. The grates and frames furnished for all surface drainage inlets shall be ductile iron for sizes 8", 10", 12", 15", 18", 24" and 30" and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting H-20 wheel loading for traffic areas or H-10 loading for pedestrian areas. 12" and 15" square grates will be hinged to the frame using pins. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron. Grates shall be provided painted black.
5. Capable of H-20 and H-25 loadings, where specified.

2.8 STORMWATER DETENTION STRUCTURES

A. Cast-in-Place Concrete, Stormwater Detention Structures: Construct of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.

1. Ballast: Increase thickness of concrete, as required to prevent flotation.
2. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of structure to finished grade is less than 36 inches.

B. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include indented top design with lettering "STORM SEWER" cast into cover.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING APPLICATIONS

- A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
 - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
 - a. Flexible or rigid couplings for same or minor difference OD pipes.
 - b. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 - c. Join dissimilar pipe materials with nonpressure-type flexible or rigid couplings.
- B. Gravity-Flow, Nonpressure Sewer Piping: Use the following pipe materials for each size range and material as indicated on drawings:
 - 1. NPS 4 and NPS 36 Corrugated PE drainage pipe and fittings, silttight couplings, and coupled joints.
 - 2. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, with groove and tongue ends.

3.3 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing stormdrain system is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.
- F. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
 - 2. Install piping below frost line.
 - 3. Install corrugated steel piping according to ASTM A 798/A 798M.
 - 4. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
 - 5. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
 - 6. Install PE corrugated sewer piping according to CPPA's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."

3.4 PIPE JOINT CONSTRUCTION

- A. Basic pipe joint construction is specified in Division 33 Section "Common Work Results for Utilities." Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join nonreinforced-concrete sewer piping according to **ASTM C 14** and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 - 2. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 - 3. Join dissimilar pipe materials with nonpressure-type flexible or rigid couplings.
 - 4. Join corrugated PE piping according to CPPA 100 and the following:
 - a. Use silttight couplings for Type 1, silttight joints.

3.5 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections according to ASTM C 891.

3.6 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Install outlets that spill onto grade, anchored with concrete, where indicated.
- C. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- D. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318/318R.

3.9 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22.

3.10 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least **8-inch-** thick, brick masonry bulkheads.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least **36 inches** below final grade. Fill to within **12 inches** of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Division 31 Section "Earth Moving."

3.11 IDENTIFICATION

1. Materials and their installation are specified in Division 31 Section "Earth Moving."

3.12 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately **24 inches** of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.

3.13 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 334100

SECTION 33 71 19
ELECTRICAL UNDERGROUND DUCTS AND MANHOLES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Conduit and duct:
 - 1. Rigid polyvinyl chloride (PVC) conduit.
 - 2. High density polyethylene (HDPE) conduit.
- B. Accessories:
 - 1. Underground warning tape.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 31 23 16 - Excavation.
- C. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
- D. Section 31 23 23 - Fill: Bedding and backfilling.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
- B. Ductbank:
 - 1. Basis of Measurement: By the lineal foot (meter), for each configuration.
 - 2. Basis of Payment: Includes purchase, delivery, and installation of duct, fittings, supports, and accessories, and for trenching, concrete encasement, and backfill.

1.04 REFERENCE STANDARDS

- A. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.
- B. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
- C. NEMA TC 7 - Smooth-Wall Coilable Electrical Polyethylene Conduit.
- D. NFPA 70 - National Electrical Code.
- E. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- F. UL 651A - Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for metallic conduit, nonmetallic conduit, and manhole accessories.
- C. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of manholes.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 CONDUIT AND DUCT

- A. Rigid Polyvinyl Chloride (PVC) Conduit: NFPA 70, Type PVC; comply with NEMA TC 2 and list and label as complying with UL 651; Schedule 40 unless otherwise indicated; rated for use with conductors rated 90 degrees C.
 - 1. Manufacturers:
 - a. Cantex Inc: www.cantexinc.com.
 - b. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com.
 - c. JM Eagle: www.jmeagle.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Fittings: Comply with NEMA TC 3 and list and label as complying with UL 651.
 - a. Manufacturer: Same as manufacturer of conduit to be connected.
- B. High Density Polyethylene (HDPE) Conduit: NFPA 70, Type HDPE; comply with NEMA TC 7 and list and label as complying with UL 651A; Schedule 40 unless otherwise indicated.
 - 1. Manufacturers:
 - a. Blue Diamond Industries, LLC: www.bdky.com.
 - b. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com.
 - c. Dura-Line: www.duraline.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ACCESSORIES

- A. Underground Warning Tape: Polyethylene tape suitable for direct burial.
 - 1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com.
 - b. Brimar Industries, Inc: www.brimar.com.
 - c. Seton Identification Products: www.seton.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
 - 3. Legend: Type of service, continuously repeated over full length of tape.
 - 4. Color:
 - a. Tape for Buried Power Lines: Black text on red background.
 - b. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.03 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify routing and termination locations of duct bank prior to excavation for rough-in.
- C. Duct bank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system.

3.02 DUCT BANK INSTALLATION

- A. Install duct to locate top of ductbank at depths as indicated on drawings.

- B. Install duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope duct away from building entrances.
- C. Cut duct square using saw or pipe cutter; de-burr cut ends.
- D. Insert duct to shoulder of fittings; fasten securely.
- E. Join nonmetallic duct using adhesive as recommended by manufacturer.
- F. Install no more than equivalent of three 90-degree bends between pull points.
- G. Provide suitable fittings to accommodate expansion and deflection where required.
- H. Terminate duct at manhole entries using end bell.
- I. Stagger duct joints vertically in concrete encasement 6 inches minimum.
- J. Use suitable separators and chairs installed not greater than 4 feet on centers.
- K. Band ducts together before backfilling.
- L. Securely anchor duct to prevent movement during concrete placement.
- M. Place concrete under provisions of Section 03 30 00. Use mineral pigment to color concrete red.
- N. Provide minimum 3 inch concrete cover at bottom, top, and sides of ductbank.
- O. Provide two No. 4 steel reinforcing bars in top of bank under paved areas.
- P. Provide suitable pull string in each empty duct except sleeves and nipples.
- Q. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- R. Interface installation of underground warning tape with backfilling. Install tape 6 inches below finished surface.

END OF SECTION

SECTION 33 79 00
SITE GROUNDING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Electrodes, connectors, and conductors.
- B. Grounding wells.
- C. Treatment wells.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems - .
- C. Section 31 23 16 - Excavation: Trenching for grounding.
- D. Section 31 23 16.13 - Trenching: Trenching for grounding.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
- B. Rod Electrode:
 - 1. Method of Measurement: Per unit.
 - 2. Includes: Purchase, delivery, and installation.
- C. Mechanical Connectors:
 - 1. Method of Measurement: Per unit.
 - 2. Includes: Purchase, delivery, and installation.
- D. Exothermic Connectors:
 - 1. Method of Measurement: Per unit.
 - 2. Includes: Purchase, delivery, and installation.
- E. Conductors:
 - 1. Method of Measurement: Per linear foot.
 - 2. Includes: Purchase, delivery, and installation.

1.04 REFERENCE STANDARDS

- A. IEEE C2 - National Electrical Safety Code.
- B. IEEE 142 - IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- C. NFPA 70 - National Electrical Code.

1.05 SYSTEM DESCRIPTION

- A. Multiple vertical electrodes buried in straight line pattern.
- B. Single vertical electrode for local grounding at utility transformer.
- C. Provide grounding systems that provide overall resistance to ground of 5 ohms.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for grounding electrodes and connectors.
- C. Shop Drawings: Indicate layout of grounding system and installation details.
- D. Test Reports: Indicate overall resistance to ground at each system.
- E. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

F. Project Record Documents: Accurately record actual locations of electrodes and connections.

1.07 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- C. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

- A. Rod Electrodes: Copper.
 - 1. Diameter: 1/2 inch.
 - 2. Length: 10 feet.
- B. Exothermic Connections:
 - 1. Product: ERICO CADWELD.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Wire: Stranded copper.
 - 1. For Horizontal Electrodes: 4/0 AWG, minimum size.
 - 2. For Connections to Electrodes: 2/0 AWG, minimum size.
 - 3. For Bonding Other Objects: 2/0 AWG, minimum size.
 - 4. Mechanical Connectors: Bronze.
- D. Grounding Well Pipe: 8 inch diameter by 24 inch long clay tile pipe with belled end.
- E. Grounding Well Cover: Cast iron with legend "GROUND" embossed on cover.
 - 1. Product: _____.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify completion of filling and backfilling before beginning grounding work.
- B. Verify that trenching is completed before installing horizontal electrodes.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install rod electrodes in vertical position with bottom at least 5 feet below frost line.
- C. Install interconnecting wire 2 feet below finished grade level.
- D. Provide grounding wells and grounding boxes as indicated.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. Make final grounding system measurements three or four days after chemical treatment.
- C. Test Procedures: IEEE 142, fall of potential method.

3.04 CLOSEOUT ACTIVITIES

- A. Demonstrate to facility operation and maintenance personnel the location of each accessible grounding connection and each chemical treatment well.

END OF SECTION

