

## SECTION 260519 – CONDUCTORS AND CABLES

### PART 1 – GENERAL

#### 1.1 SECTION INCLUDES

- A. Building wire and cable.
- B. Wiring connectors and connections.

#### 1.2 RELATED SECTIONS

- A. Section 260553 – Electrical Identification.

#### 1.3 REFERENCES

- A. Quality Control: Follow requirements for references and standards.
- B. NECA Standard of Installation (National Electrical Contractors Association).
- C. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).
- D. NFPA 70 - National Electrical Code.

#### 1.4 SUBMITTALS FOR REVIEW

- A. Submittals: Follow procedures for submittals.
- B. Product Data: Provide for each cable assembly type.

#### 1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Contract Closeout Submittals – Follow as required.
- B. Project Record Documents: Record actual locations of components and circuits.

#### 1.6 QUALIFICATIONS

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

#### 1.7 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories Inc., or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

## 1.8 PROJECT CONDITIONS

- A. Verify that field measurements are as indicated.
- B. Conductor sizes are based on copper only.
- C. Wire and cable routing indicated is approximate unless dimensioned.

## 1.9 COORDINATION

- A. Coordinate Work under provisions of Section 260500.
- B. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

## PART 2 - PRODUCTS

### 2.1 BUILDING WIRE

- A. Manufacturers:
  - 1. Okonite Company
  - 2. Alpha Wire Company
  - 3. Southwire
  - 4. Substitutions: Follow as required for Material and Equipment.
- B. Description: Multi-stranded insulated copper wire, #12 AWG minimum for feeders and branch circuits and #14 AWG minimum for control circuits.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation: NFPA 70; Type XHHW or THWN insulation for service, feeders and branch circuits and control circuits.

### 2.2 WIRING CONNECTORS

- A. Use split bolt connectors for copper conductor splices and taps, #6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
- B. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, #8 AWG and smaller. Buchanan crimp (Split cap and insulator) or Ideal crimp connector with wrap cap insulator.
- C. Use Adhesive-lined heat shrink tubing for watertight connections; T & B, 3M, or Raychem.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that mechanical work likely to damage wire and cable has been completed.

### 3.2 PREPARATION

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

### 3.3 INSTALLATION

- A. Quality Control: Follow as required by manufacturer's instructions.
- B. Route wire and cable as required to meet Project Conditions.
- C. Install cable in accordance with the NECA "Standard of Installation."
- D. Use stranded conductors for control circuits.
- E. Use conductors not smaller than #12 AWG for power and lighting circuits.
- F. Use conductors not smaller than #14 AWG for control circuits.
- G. Use #10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet (25 m).
- H. Pull all conductors into raceway at same time.
- I. Use suitable wire pulling lubricant for building wire #4 AWG and larger.
- J. Protect exposed cable from damage.
- K. Use suitable cable fittings and connectors.
- L. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- M. Clean conductor surfaces before installing lugs and connectors.
- N. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- O. Use split bolt connectors for copper conductor splices and taps #6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
- P. Use solderless pressure connectors with insulating covers for copper conductor splices and taps #8 AWG and smaller.
- Q. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps #10 AWG and smaller.
- R. Identify and color code wire and cable under provisions of Section 260553. Identify each conductor with its circuit number or other designation indicated.
- S. Replace conductors damaged during installation.
- T. No splices are allowed in conduits or raceways.

### 3.4 FIELD QUALITY CONTROL

- A. Starting of Systems: Follow requirements for field inspection, testing, and adjusting.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION 260519

## SECTION 260526 – GROUNDING AND BONDING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Bonding.

#### 1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code.

#### 1.3 GROUNDING SYSTEM DESCRIPTION

- A. The system shall consist of a series of driven ground rod electrodes interconnected with bare stranded ground conductor.
- B. All building footer and slab rebar greater than ½” shall be bonded to the ground conductor. Bond at 20 ft intervals and at each corner. IAW NEC. Connections to rebar may be made with suitable sized ground clamps.
- C. All connections shall be by exothermic welds (Cadweld or equal) installed according to the manufacturer's instructions.
- D. Tests shall be performed to determine the grounding grid resistance to ground. The test method shall be as described in NETA Standard ATS-1987, "Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems." A three-point fall-of-potential test shall be used using two auxiliary electrodes for the measurement. Test reports shall be provided describing the testing procedure and results. The grid-to-ground resistance shall be no greater than 5 ohms. If necessary, additional rods shall be added to achieve the 5-ohm ground. When the Contractor has obtained satisfactory results, he shall submit test reports to the Engineer for approval. After approval, the contractor shall bond the service entrance ground grid to the service entrance enclosure ground bus. The Owner or Owner's representative shall have the opportunity to inspect all exothermic welds.
- E. All ground cables shall have a minimum of 24" of ground cover.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 5 ohms maximum.

#### 1.5 SUBMITTALS

- A. Product Data: Provide for grounding electrodes and connections.
- B. Test Reports: Indicate overall resistance to ground (and resistance of each electrode).
- C. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

## 1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 260500.
- B. Accurately record actual locations of grounding electrodes.

## 1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc.

## PART 2 - PRODUCTS

### 2.1 ROD ELECTRODE

- A. Manufacturers:
  - 1. ITT Blackburn Co.
  - 2. Copperweld, Bimetallic.
  - 3. American Electric - Blackburn.
- B. Material: Copper-clad steel.
- C. Diameter: 3/4 inch.
- D. Length: 10 feet.

### 2.2 MECHANICAL CONNECTORS

- A. Manufacturers:
  - 1. Burndy Corp.
  - 2. O-Z/Gedney.
- B. Material: Bronze.

### 2.3 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
  - 1. Cadweld.

### 2.4 WIRE

- A. Material: Bare stranded copper.
- B. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground spaced at minimum 10 ft.
- C. Provide bonding to meet Regulatory Requirements.
- D. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

### 3.3 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

END OF SECTION 260526

## SECTION 260529 – SUPPORTING DEVICES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Conduit and equipment supports.
- B. Anchors and fasteners.
- C. Concrete equipment supports

#### 1.2 REFERENCES

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

#### 1.3 SUBMITTALS

- A. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

#### 1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

### PART 2 - PRODUCTS

#### 2.1 PRODUCT REQUIREMENTS

- A. Materials and Finishes: Provide adequate corrosion resistance.
- B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
- C. Anchors and Fasteners:
  - 1. Concrete block walls: Use expansion anchors.
  - 2. Steel Structural Elements: Use welded fasteners.
  - 3. Concrete Surfaces: Use expansion anchors.

## 2.2 CHANNEL SYSTEMS

- A. Manufacturer:
  - 1. Unistrut
  - 2. B-Line
  - 3. Allied
  - 4. Power -Strut
  - 5. or Equal
  
- B. Description:
  - 1. Galvanized steel – General locations
  - 2. Aluminum – Wet, damp areas
  - 3. Stainless steel – Wet, damp corrosive areas where compatible with chemicals
  - 4. Fiberglass – Wet, damp, corrosive areas where compatible with chemicals
  
- C. Size: 1-5/8" x 1-5/8"

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
  
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
  
- C. Do not fasten supports to pipes and conduit except as shown on Drawings.
  
- D. Obtain permission from Engineer before drilling or cutting structural members.
  
- E. Fabricate supports from structural steel, galvanized steel, aluminum or stainless steel channel. Rigidly weld members or use stainless steel hex head bolts and hardware to present neat appearance with adequate strength and rigidity. Use spring-lock washers under all nuts.
  
- F. Install surface-mounted cabinets and panel boards with minimum of four anchors.
  
- G. In wet and damp locations use stainless steel or aluminum channel supports with stainless steel fasteners.
  
- H. In wet and damp locations use stainless steel or aluminum spacers to stand cabinets and panel boards one inch off wall.
  
- I. Spray coat cut end of galvanized steel channel or rigid steel conduit with spray cold galvanizing.
  
- J. Galvanized pipe used as equipment supports are to have the open ends capped with galvanized end caps.

- K. Provide concrete equipment pad, housekeeping pads, for all equipment that will be floor mounted. Pads to be formed, chamfer edges, and have a troweled finish. Concrete shall be smoothed around conduits. Equipment panels shall be anchored using concrete anchors. Equipment pads for outdoor mounted panels shall extend from the front of the equipment panel 3'-6" min. to allow for opening and standing.

END OF SECTION 260529

## SECTION 260530 – ELECTRICAL DUCT BANK

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. PVC conduit.
- B. Pull Boxes/Handhole Enclosures

#### 1.2 MEASUREMENT AND PAYMENT

- A. Duct bank:
  - 1. Basis of Payment: Includes purchase, delivery, and installation of duct, fittings, supports, accessories, trenching, aggregate bedding or concrete encasement (where required), and backfill.
- B. Pull Boxes/Handhole Enclosures
  - 1. Basis of Payment: Includes purchase, delivery, and installation of pull box.

#### 1.4 REFERENCES

- A. Quality Control: Follow requirements for references and standards.
- B. ASTM C857 - Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
- C. ASTM C858 - Underground Precast Concrete Utility Structures.
- D. STM C891 - Installation of Underground Precast Utility Structures.
- E. ASTM C1037 - Inspection of Underground Precast Utility Structures.
- F. IEEE C2 - National Electrical Safety Code.
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- H. NEMA TC 2 and TC3 - Schedule 40 PVC Conduit and PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- I. NFPA 70 - National Electrical Code.
- J. UL 651A - Type EB and A PVC Conduit and HDPE Conduit.
- K. ANSI/SCTE 77-2007 Specifications for Underground Enclosure Integrity.

#### 1.5 SUBMITTALS FOR REVIEW

- A. Submittals: Follow procedures for submittals.
- B. Product Data: Provide for manhole accessories.
- C. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.

## 1.6 SUBMITTALS FOR INFORMATION

- A. Follow requirements for submittals in general project requirements.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

## 1.7 SUBMITTALS FOR CLOSEOUT

- A. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of manholes.

## 1.8 REGULATORY REQUIREMENTS

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

## 1.9 FIELD SAMPLES

- A. Provide as required.

## 1.10 FIELD MEASUREMENTS

- 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.
- D. Pull box locations and quantity are shown in approximate locations. Locate as required to complete duct bank system.

## PART 2 - PRODUCTS

### 2.1 PLASTIC CONDUIT

- A. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 PVC, with fittings and conduit bodies to NEMA TC 3.
- B. Rigid Plastic Underground Conduit: UL 651A, Type A PVC.

### 2.2 DUCT BANK PULL BOXES

- A. Description: Pull boxes shall be as manufactured by Quazite.
- B. Load capacity of box to be as indicated on drawings or as indicated in ANSI SCTE-77-2007.
- C. Provide all necessary items for a complete installation.
- D. Pull boxes shown are approximate sizes. Size pull boxes as required for proper installation.

E. Enclosure With Walls 48" or Shorter

1. Enclosures, boxes and cover are required to conform to all test provisions of ANSI/SCTE 77 "Specifications For Underground Enclosure Integrity" for Tier as shown on Drawings. When multiple Tiers are specified, the boxes must physically accommodate and structurally support compatible covers while possessing the highest Tier rating. In no assembly can the cover design load exceed the design load of the box. All components in an assembly (box & cover) are manufactured using matched surface tooling. All covers are required to have a minimum coefficient of friction of 0.05 in accordance with ASTM C1028 and the corresponding Tier level embossed on the top surface. Independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met are required with each submittal.

2.3 ACCESSORIES

- A. Underground Warning Tape: 4 inch wide plastic tape, metal-backed, colored red or yellow with suitable warning legend describing buried electrical lines.
- B. Underground conduit PVC support chairs

PART 3 - EXECUTION

3.1 DUCT BANK INSTALLATION

- A. Quality Control: Follow requirements in manufacturer's instructions.
- B. Install duct to locate top of duct bank at depths as indicated on drawings.
- C. Install duct with minimum slope of 4 inches per 100 feet. Slope duct away from building entrances.
- D. Cut duct square using saw or pipe cutter; de-burr cut ends.
- E. Insert duct to shoulder of fittings; fasten securely.
- F. Join nonmetallic duct using adhesive as recommended by manufacturer.
- G. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- H. Install no more than equivalent of three 90-degree bends between pull points.
- I. Use suitable separators and chairs installed not greater than 4 feet on centers.
- J. Conduit spacing shall be 12" minimum from 480/277 volt conduits to mA/communication signal conduits and 6" minimum from 120/240 volt conduits and mA/communication signal conduits.

- K. Provide suitable pull string in each empty duct.
- L. Swab duct with wire brush and mandrel. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- M. Backfill as required in Final Backfill paragraph of Underground Conduit Installation Section. Aggregate bedding shall be placed and tamped in layers. Bedding shall be placed in trench bottom prior to installation of the bottom ducts.
- N. Concrete encasement required where indicated. Ensure that concrete totally encases conduits in duct bank to eliminate any voids.
- O. Interface installation of underground warning tape with backfilling as required in Final Backfill paragraph of Underground Conduit Installation Section. Install tape 6 inches below finished surface.
- P. Install a vertical two-foot length of #8 rebar to extend to 6" below finish grade at each duct bank intersection, bend and at 100 ft intervals of straight duct bank run for locating the duct bank

### 3.3 PULL BOXES/HANDHOLE ENCLOSURES

- A. Quality Control: Follow requirements in manufacturer's instructions.
- B. Excavate hole approximately 8" deeper than the depth of the pull box at finished grade and approximately 8" larger than the box. Provide minimum of 6 – 8 inches of gravel in the excavation bottom. Compact gravel to minimize settling.
- C. Set box on compacted gravel and backfill to finished grade.
- D. Install in accordance with NEC 314.30.

END OF SECTION 260530

## SECTION 260533 – CONDUIT

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Metal conduit.
  - 1. Rigid Galvanized Steel
  - 2. Aluminum
- B. PVC coated rigid galvanized steel.
- C. Nonmetallic conduit.
- D. Flexible metal conduit.
- E. Liquid-tight flexible metal conduit.
- F. Fittings and conduit bodies.

#### 1.2 RELATED SECTIONS

- A. Section 260529 – Supporting Devices.
- B. Section 260553 – Electrical Identification.
- C. Sections 260534 – Boxes and Enclosures.

#### 1.3 REFERENCES

- A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
- B. ANSI C80.5 - Rigid Aluminum Conduit
- C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- D. ANSI/NFPA 70 - National Electrical Code.
- E. NECA "Standard of Installation."
- F. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- G. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

#### 1.4 DESIGN REQUIREMENTS

- A. Conduit Size: ANSI/NFPA 70.

#### 1.5 SUBMITTALS

- A. Submit under provisions of Section 013323.
- B. Product Data: Provide for metallic conduit, flexible metal conduit, liquid-tight flexible metal conduit, nonmetallic conduit, flexible nonmetallic conduit, fittings, conduit bodies of each type planned to be used.

## 1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of project general requirements.
- B. Accurately record actual routing of all conduits exposed and concealed on record drawings.

## 1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc as suitable for purpose specified and shown.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle Products to site under provisions of Section 016600.
- 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.

## 1.9 PROJECT CONDITIONS

- A. Verify routing and termination locations of conduit prior to rough-in.
- B. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

## PART 2 - PRODUCTS

### 2.1 CONDUIT REQUIREMENTS

- A. Minimum Size: 3/4 inch unless otherwise specified.
- B. Underground Installations:
  - 1. More than two feet from Foundation Wall: Use schedule 40 PVC conduit.
  - 2. Within two feet from Foundation Wall: Use plastic coated galv. rigid conduit.
  - 3. In or Under Slab on Grade: Use schedule 40 PVC conduit.
  - 4. When changing from underground to above ground, use PVC coated galv. rigid conduit to approximately two feet above finished grade.
  - 5. Conduits passing through poured concrete sidewalks, floating type slabs on grade shall be sleeved.
- C. Outdoor Locations, Above Grade: Use rigid galvanized steel conduit.
- D. In Slab Above Grade:
  - 1. Use schedule 40 PVC.
  - 2. Maximum Size Conduit in Slab: 3/4" for conduits crossing each other.
- E. Continuously Wet and Damp Locations: Use aluminum or PVC coated rigid steel conduit.
- F. Corrosive Location: Use PVC coated rigid steel or schedule 40 PVC.

- G. Dry Locations:
  - 1. Concealed in framed wall or above suspended ceilings: Use steel electrical metallic tubing or schedule 40 PVC conduit.
  - 2. Exposed: Use rigid galvanized steel or aluminum conduit or as noted on drawings.
  - 3. Flexible metal conduit can be used for equipment connections. Max length of 3ft.
- H. Classified hazardous Class 1, Division 1 areas & Screen Rooms: PVC coated rigid steel conduit and explosion-proof flexible equipment connections.
- I. Equipment Connections:
  - 1. Use liquid-tight flexible metal conduit.
  - 2. In corrosive or chemical rooms, use non-metallic flexible conduit and fittings.
- J. Flexible conduits lengths shall be limited to three feet or less.

## 2.2 METAL CONDUIT

- A. Rigid Steel Conduit: ANSI C80.1.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1 all steel fittings.

## 2.3 PVC COATED METAL CONDUIT

- A. Manufacturers:
  - 1. Robroy Industries "Plasti-Bond."
  - 2. Thomas & Betts – "OCAL Blue".
- B. Description: NEMA RN 1; rigid steel conduit with external PVC coating, 40 mil thick.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel fittings with external PVC coating to match conduit.

## 2.4 FLEXIBLE METAL CONDUIT

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

## 2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
  - 1. Sealtight VA Anaconda Metal Hose Div.
  - 2. Liquidtight type L.A. Electric Flex Co.
- B. Description: Interlocked aluminum construction with PVC jacket.
- C. Fittings: ANSI/NEMA FB 1.

## 2.6 NONMETALLIC CONDUIT

- A. Manufacturers:
  - 1. Carlon Electrical Products Div.
  - 2. LCP
  - 3. Quil
- B. Description: NEMA TC 2; Schedule 40 PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install conduit in accordance with NECA "Standard of Installation."
- B. Install nonmetallic conduit in accordance with manufacturer's instructions.
- C. Arrange supports to prevent misalignment during wiring installation.
- D. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- E. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.
- F. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.
- G. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports
- H. Do not attach conduit to ceiling support wires.
- I. Arrange conduit to maintain headroom and present neat appearance.
- J. Route exposed conduit parallel and perpendicular to walls.
- K. Route conduit in and under slab from point-to-point.
- L. Do not cross conduits in slab unless 3/4".
- M. Maintain adequate clearance between conduit and piping.
- N. Maintain 12-inch clearance between conduit and surfaces with temperatures exceeding 104°F.
- O. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- P. Bring conduit to shoulder of fittings; fasten securely.
- Q. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- R. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- S. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inch size.
- T. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- U. Provide suitable fittings to accommodate expansion and deflection where conduit crosses, control and expansion joints.

- V. Conduits shall be sloped in such a manner that water may drain to the closest pull box if possible.
- W. Provide suitable pull string in each empty conduit except sleeves and nipples.
- X. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- Y. Ground and bond conduit under provisions of Section 260526.
- Z. Identify conduit under provisions of Section 260553.
- ZA. Flexible conduit, non-metallic, liquid-tight and metallic, shall not be used in lengths longer than 6 feet unless specifically approved. Flexible conduit is not to be used in place of neatly run rigid conduit.
- ZB. Where called out on plans provide cable terminators / sealing bushings, CRC by O-Z/Gedney or approved equal. Verify specific cable outside diameters and follow manufacturer's installation requirements.

END OF SECTION 260533

## SECTION 260534 – PULL, JUNCTION BOXES AND ENCLOSURES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pull Boxes
- B. Junction Boxes
- C. Accessories

#### 1.2 RELATED SECTIONS

- A. Section 260529 - Supporting Devices.

#### 1.3 REFERENCES

- A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- B. NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.
- C. ANSI/NFPA 70 - National Electrical Code.

#### 1.4 SUBMITTALS

- A. Submit under provisions of general project requirements and Section 260500.
- B. Product Data: Provide manufacturer's standard data for boxes and enclosures.
- C. Junction box locations and details
  - 1. Terminal block layout
  - 2. Grounding

#### 1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Hoffman
- B. Rittal
- C. or equal

## 2.2 PULL BOXES

### A. Construction:

1. Outdoors, Wet Damp areas, Corrosive areas. NEMA Type 4/4X, sunlight resistant fiberglass, polycarbonate or SS as specified on Drawings, enclosure with continuous hinge covers.
  - a. Covers: Continuous SS hinge, held closed by SS screws
2. Indoors exposed NEMA 12, 13 or as specified on Drawings.
3. Indoors flush wall mounted NEMA 1 w/ flush covers
4. Indoors concealed NEMA 1 w/ screw cover
5. Indoor wet and damp NEMA 4XSS
6. Indoor corrosive areas NEMA 4XSS or compatible with chemical
7. Hazardous locations NEMA 7

## 2.3 TERMINAL HINGED COVER ENCLOSURES

### A. Construction:

1. Outdoor, Wet Damp areas, Corrosive areas: NEMA 4/4X, sunlight resistant fiberglass or polycarbonate or stainless steel (SS) as specified on Drawings, Type 4/4X enclosure with continuous hinge cover.
    - a. Covers: Continuous SS hinge, held closed by flush latch operable by screwdriver.
  2. Indoors, exposed: NEMA 12, 13
  3. Indoors, flush wall mounted: NEMA 1 w/ flush covers
  4. Indoors, concealed: NEMA 1 w/ screw cover
  5. Indoors, wet and damp: NEMA 4XSS
  6. Indoors, corrosive areas: NEMA 4XSS or compatible with chemical
  7. Hazardous locations: NEMA 7
- B. Provide white enamel interior metal panel for mounting terminal blocks and electrical components.

## 2.4 CABINETS

- A. Provide metal barriers to form separate compartments containing control wiring at less than 50 volts from power wiring.
- B. Provide accessory feet for free-standing equipment.

## 2.5 TERMINAL BLOCKS

### A. Manufacturers:

1. Weidmüller SAK 6, SAK 2.5, ASK 1.
  2. Allen-Bradley
  3. Square-D
  4. or equal
- B. Terminal Blocks: ANSI/NEMA ICS 4.
- C. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

- D. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts. Ground terminal shall be green.
- E. Provide ground bus terminal block, with each connector bonded to enclosure.
- F. Provide a typed legend of cables and terminal numbers with origin and destination.
- G. Boxes where water may drain from the attached conduits shall have drains installed in the bottom or the lowest point of the box. Conduit penetration at such boxes shall be located along the sides or top of the box. Conduits shall not be installed in a manner that water can enter attached pull conduits.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.
- C. Do not attach boxes directly to masonry, concrete, or brick walls but provide a ¼ inch spacer of PVC, nylon, or stainless steel.
- D. Install enclosures and boxes using stainless steel fasteners.
- E. Provide supports where required when no wall or other adequate support is available.

END OF SECTION 260534

## SECTION 260553 – ELECTRICAL IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Nameplates and labels.
- B. Wire and cable markers.
- C. Conduit markers.

#### 1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.

#### 1.3 SUBMITTALS

- A. Submit under provisions of Section 260500.
- B. Product Data: Provide catalog data for nameplates, labels, and markers.

#### 1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc.

### PART 2 - PRODUCTS

#### 2.1 NAMEPLATES AND LABELS

- A. Nameplates:
  - 1. Equipment Identification: Engraved three-layer laminated plastic, black letters on white background.
  - 2. Emergency Powered Equipment: Engraved three-layer laminated plastic, black letters on red background. As required by NEC
  - 3. Equipment power source identification: Engraved three-layer laminated plastic, black letters on yellow background.
- B. Locations:
  - 1. Each electrical distribution and control equipment enclosure.
  - 2. Junction box.
- C. 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.

- D. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background. Use only for identification of individual wall switches and receptacles, and control device stations.

## 2.2 WIRE MARKERS

- A. Manufacturers:
  - 1. T & B Shrink-Kon HVM wire markers.
  - 2. Panduit - Pan Code HSDL.
  - 3. Brady.
- B. Description: Tubing type wire markers.
- C. Locations: Each conductor at panelboard gutters, outlet and junction boxes, terminal strip and each load connection.
- D. Legend:
  - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on Drawings.
  - 2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on drawings or on shop drawings.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Degrease and clean surfaces to receive nameplates and labels.

### 3.2 APPLICATION

- A. Install nameplate parallel to equipment lines.
- B. Secure nameplate to equipment front using stainless steel screws, rivets, or adhesive.
- C. Identify underground conduits using foil backed underground warning tape. Install one tape per trench at 6 inches below finished grade.

END OF SECTION 260553

## SECTION 262419 – MOTOR CONTROL CENTERS

### PART 1 - GENERAL

#### 1.1 SCOPE

- A. Motor control center (MCC) applies to all equipment designated as such on the Drawings. MCCs are pre-designed and factory assembled multiple unit assemblies, including:
  - 1. Floor standing metal enclosure,
  - 2. Power bussing,
  - 3. Removable isolated electrical distribution and control units as shown on the Drawings and as specified below.

#### 1.2 REFERENCES

- A. The MCC shall meet or exceed the requirements within the following standards for MCCs.
  - 1. NEMA ICS 18 - Industrial Control and Systems: Motor Control Centers
  - 2. UL 845 - UL Standard for Safety for Motor Control Centers
  - 3. NOTE: UL 845 is a harmonized standard consisting of:
    - a. Underwriters Laboratories Inc. (UL) UL 845
    - b. Association of Standardization and Certification (ANCE) NMX-J-353-ANCE-2006
    - c. Canadian Standards Association (CSA) C22.2 No. 254-05
  - 4. NFPA 70 - National Electrical Code
- B. The MCC shall be designed, manufactured, and tested in facilities registered to ISO 9001.

#### 1.3 SUBMITTALS

- A. Submittals for approval shall include descriptive and assembly literature, specification information, component layouts, and wiring schematics.
- B. Submit documentation in accordance with Section 013300.

#### 1.4 REGULATORY REQUIREMENTS

- A. Contractor shall ensure that the installation conforms to the requirements of the latest edition of the NFPA 70 National Electrical Code and/or other applicable installation standards.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. The contractor shall coordinate the shipping splits with the MCC manufacturer for

entry into the building.

- B. Shipping splits shall be noted on the MCC manufacturer drawings.
- C. The contractor shall store the MCCs in a clean, dry, and heated space.
- D. The contractor shall protect the units from dirt, water, construction debris, and traffic.
- E. During storage the contractor shall connect internal space heaters (if specified) with temporary power.
- F. MCCs are to be shipped with external lifting angles at the top and running continuously for each shipping split. Lifting eyelets are not acceptable.

## 1.6 ENVIRONMENTAL REQUIREMENTS

- A. The MCC enclosure rating shall be appropriate for the environment where the MCC is to be located.

## 1.7 FIELD MEASUREMENTS

- A. The contractor shall verify all field measurements prior to the fabrication of the MCC or components to be installed in existing units.

## 1.8 WARRANTY

- A. The manufacturer shall provide their standard parts warranty for 18 months from the date of shipment or 12 months from the date of being energized, whichever occurs first.
- B. The manufacturer shall confirm this warranty as part of the submittal.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Assembly: Design, assemble, and test in accordance with the applicable standards of NEMA and the National Electrical Code.
- B. Manufacturer: Components shall be compatible with existing Allen-Bradley / Rockwell Automation MCC. A-B Order No. NGCXG95/01.
- C. Identification
  - 1. Provide a durable engraved nameplate on each motor control center, with 1" high letters, indicating the name of the motor control center. (e.g. "MCC-1").
  - 2. Provide a nameplate on each section indicating Manufacturer, model, date of manufacture, and electrical ratings.

3. Provide a removable nameplate on each unit with the name of the circuit (e.g. "PUMP NO. 3", "MAIN CIRCUIT BREAKER").
4. Motor starters, circuit breakers, switches, and other components shall have model and ratings indicated on the component.

## 2.2 ELECTRICAL RATINGS

- A. Voltage: 480 volts, 60 Hz, 3 phase, 4 wire.
- B. Bus Bracing: 42,000 amperes.
- C. Horizontal Bus: Top or center. Copper. 600 ampere.
- D. Vertical Bus: Copper, all sections with more than one unit, 600 ampere.
- E. Ground Bus: Copper, all sections, 300 ampere.

## 2.3 STRUCTURE

- A. The MCC shall be of dead front construction and shall consist of one or more vertical sections bolted together to form a rigid, free-standing assembly. The systems shall be designed to allow for the addition of future sections at either end and to permit the interchanging of units.
- B. Vertical sections shall be rigid, free-standing structures.
  1. Vertical sections shall have internal mounting angles running continuously within the shipping block.
  2. An external mounting channel that is required to maintain structure integrity is not acceptable.
  3. Vertical sections shall be 90 in. high, 20 in. deep and 20 in. Wide, except where larger dimensions are required.
  4. Vertical sections shall be provided with a removable steel lifting angle on all shipping blocks. The angle shall run the length of the shipping block.
  5. Lifting eyes are not acceptable.
  6. Each standard section shall be capable of being subdivided into 12 usable, unit spaces.
  7. Two unit spaces shall constitute one space factor and shall be 13 in. in height.
  8. One unit space shall constitute one-half space factor and shall be 6.5 in. in height.

## 2.4 CONSTRUCTION

- A. General
  1. Arrange as shown on the drawings if possible. Alternate arrangements must be logical and approved.
  2. Contractor is responsible for any cost incurred by dimensions larger than those shown on the Drawings.

3. Finish: Manufacturer's standard oven-baked enamel. Phosphatizing pre-paint treatment. Inside of units white or near white color. All unpainted pans, barriers, and hardware shall be cadmium or chromate plated.

B. Enclosure

1. Provide adequate conduit space top and bottom for each application. Arrange horizontal bus-bars for minimum interference.
2. Isolated vertical wireway with separate removable door for each vertical section containing more than one unit. Minimum cross-section 28 square inches.
3. Horizontal wireways minimum cross-section 40 square inches, each top and bottom.
4. All metal non-conducting parts electrically continuous.
5. Doors interlocked with disconnect operator to prevent opening while disconnect is closed, and prevent closing the disconnect while the door is open. Screwdriver defeater.
6. All units shall have hinged doors secured closed by captive hand screws. Removable pin hinges. Spare spaces shall have same type of doors, maximum height 18 inches.
7. All compartments and connections shall be accessible from the front unless back-to-back is indicated.
8. NEMA Type 1, unless otherwise indicated.

C. Bus-bars

1. Contact surfaces and unit stabs tinned, or silver plated copper.
2. All bus-bar connections easily accessible with simple tools.
3. Glass reinforced polyester bus-bar mounting and insulating barriers to prevent accidental contact, and for phase isolation.

D. Miscellaneous

1. Equipment units rated up to 100 amperes shall be plug-in type. Larger units may be bolt-in. Plug-in fingers shall be high pressure two-point connections.
2. All wiring terminals and adjustments accessible when door is open without removal of mounting screws.
3. All control terminals shall be pull-apart type.

## 2.5 UNIT PROVISIONS

- A. Engraved nameplate on the door showing equipment name.
- B. Switch or circuit breaker operating handle with provisions for padlocking in the OFF position; three locks.
- C. Complete with fuses.
- D. Individual control power transformers for starter and contactor units, unless otherwise indicated on the Drawings. 100 VA minimum capacity, extra capacity

as noted on the Drawings, or as necessary for extra equipment. 120 volt controls, secondary fuse.

- E. Solenoid coils: 480 volts on Size 5 contactors and starters; 120 or 480 volts on Size 4 starters as noted on the Drawings; 120 volts on Sizes 1, 2, and 3.
- F. Provide auxiliary contacts, relays, timers, devices, and terminal board for the functions shown in the control diagrams. Minimum number of auxiliary contacts each starter 1-NO and 1-NC. All contacts shall be rated at least twice the current requirements of the circuit, minimum 5 amperes continuous.
- G. Control devices: 600 volt heavy duty.
- H. Indicator lights: LED type.
- I. Wire controls as per control diagrams on the Drawings, NEMA type 1-B. Secure label on each end of each conductor. Provide as many outgoing terminals as called for, plus minimum of three spares in each unit.

## 2.6 MOTOR STARTERS

- A. Type: Magnetically held contactor, three-pole, NEMA design.
- B. Power Contacts: Double break with wiping action, 600 volts.
- C. Overloads: Manual reset with 30% unbalanced phase sensing.
- D. Minimum Size: NEMA Size 1.
- E. Motor Horsepower: Horsepower shown is estimated only. Starter and overload heaters must be coordinated with the actual equipment installed.

## 2.7 OVER-CURRENT PROTECTION

- A. Circuit Breakers
  - 1. Thermal Trips: Bi-metal inverse time curve. Continuous ratings as shown on the Drawings, except coordinate ratings for motor starters with actual equipment installed.
  - 2. Magnetic Trips: 10X thermal rating, nominal.
  - 3. Interrupting Capacity: Symmetrical current rating 14,000 amperes, or as indicated.
  - 4. Identification: Display on the circuit breaker continuous ampere rating, magnetic trip rating, and fault current interrupting rating in amperes.
- B. Motor Circuit Protectors (MCP)
  - 1. Application: May be used for motor starter disconnect in lieu of circuit breakers.

2. Magnetic Trip: Adjustable within range of 7 to 13 times full load amps of the actual motor installed. Field set at approximately 20% above locked rotor current.
3. Interrupting Capacity: 14,000 amperes, or as indicated.
4. Identification: Display on the MCP continuous ampere rating, magnetic trip adjustment, and fault current interrupting capacity in amperes.

C. Fusible Switches

1. For branch circuits as indicated.
2. 3-pole heavy duty; quick-make quick-break.
3. Fuses: Unless otherwise indicated, dual element time delay, Class RK-5.

2.8 METERING

- A. Meters and metering transformers as noted on the Drawings shall be suitable for the purpose and provide reading accuracy of 1.5 % of full scale. Overload for ammeters, 2X continuous, 50X for one second.

2.9 TIMERS

A. Unless otherwise noted:

1. Time Range: 0 - 60 seconds
2. Type: Pneumatic dash-pot relay action
3. Contact Ratings: 300 or 600 volts, 10 ampere.

2.10 SOLID STATE MOTOR CONTROLLERS

A. Ratings

1. Volts: 480 volts, 3 phase, 3 wire
2. Amperes: Continuous rating as indicated on the Drawings
3. Control Volts: 120 volt control power transformer.

B. Branch Disconnect: Thermal magnetic circuit breaker, as specified above.

C. Isolation and Bypass Contactor: NEMA rated for the application.

D. Capacitor Contactor: NEMA rated for switching capacitors.

E. Motor Overload: Thermal overloads, manual reset with current transformers, 30% unbalanced phase sensing.

F. Programming and Metering: Incorporate on each unit programming buttons and LCD display for three-phase amperes.

G. Basis of Specification: Allen-Bradley SMC DIALOGUE PLUS, standard duty.

#### H. Control Function (Typical)

1. Pump control mode with soft start and soft stop.
2. Isolated auxiliary contact control output to indicate "run" (Form C, 10 ampere)
3. Energizing start terminal closes auxiliary contact output, which energizes the capacitor contactor and the isolation contactor, and starts the voltage ramp function. When full voltage is reached the bypass contactor closes.
4. De-energizing the soft stop terminal de-energizes the bypass contactor and begins the voltage decrease function. When the voltage decreases to zero, the auxiliary contact opens, de-energizing the capacitor and isolation contactors.

### PART 3 - EXECUTION

#### 3.1 ACCESSORIES

- A. Special Tools: Provide two sets of special tools recommended for installation, maintenance, or adjustment of equipment specified in this Section. Provide tools in a metal box complete with handle and lockable latch.
- B. Spare Fuses: Provide, at the completion of the Project, 10% spare fuses of each size and type installed, including power and controls, but not less than three of each size and type.

#### 3.2 INSTALLATION

- A. Install unit within existing motor control center.

END OF SECTION

## SECTION 262816 – ENCLOSED SWITCHES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Fusible switches.
- B. Safety Disconnect switches

#### 1.2 RELATED SECTIONS

- A. Section 260553 – Electrical Identification

#### 1.3 REFERENCES

- A. NECA - Standard of Installation (published by the National Electrical Contractors Association).
- B. NEMA FU1 - Low Voltage Cartridge Fuses.
- C. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (published by the International Electrical Testing Association).
- E. NFPA 70 - National Electrical Code.

#### 1.4 SUBMITTALS FOR REVIEW

- A. Follow requirements for submittals, procedures for submittals, in general project requirements.
- B. Product Data: Provide switch ratings and enclosure dimensions.

#### 1.5 SUBMITTALS FOR CLOSEOUT

- A. Record actual locations of enclosed switches in project record documents.

#### 1.6 REGULATORY REQUIREMENTS

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

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Follow requirements for material and equipment in general project requirements: Product options and substitutions.
- B. Cutler Hammer
- C. Eaton
- D. Square-D
- E. Siemens Energy and Automation
- F. General Electric
- G. Substitutions: Engineer Approved Equal.

### 2.2 FUSIBLE SWITCH ASSEMBLIES

- A. Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.
- B. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.
- C. Short Circuit rating: 200,000 amps

### 2.3 ENCLOSURES

- A. Fabrication: NEMA KS 1.
  - 1. Interior Dry Locations: Type 1 or 12 as indicated on Drawings.
  - 2. Exterior Locations: Type 4X SS.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install in accordance with NECA "Standard of Installation."
- B. Install fuses in fusible disconnect switches.
- C. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

### 3.2 FIELD QUALITY CONTROL

- A. Follow requirements for Starting of Systems in general project requirements: Field inspection, testing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION 262816