

## SECTION 26 42 00

### CATHODIC PROTECTION

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Cathodic protection rectifiers.
- B. Impressed current anodes.
- C. Anode shunt junction box.
- D. Bonding boxes.
- E. Terminals and terminal blocks.
- F. Insulating flange kits.
- G. Sacrificial anodes.
- H. Cathodic protection and bonding cables.
- I. Test stations.
- J. Nameplates, nameplate bar
- K. Accessories

##### 1.02 RELATED SECTIONS

- A. Grounding and bonding requirements and procedures are specified in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

##### 1.03 MEASUREMENT AND PAYMENT

- A. General: Cathodic protection, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump-sum price for Electrical Work as indicated in the Bid Schedule of the Bid Form.

##### 1.04 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM D1248 Specification for Polyethylene Plastics Molding and Extrusion Materials
  - 2. ASTM D3032 Test Methods for Hookup Wire Insulation
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - 1. IEEE 316 Requirements for Direct Current Instrument Shunts

- C. National Association of Corrosion Engineers (NACE):
  - 1. NACE RP0169 Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- D. National Electrical Manufacturer's Association (NEMA):
  - 1. NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches
  - 2. NEMA ICS 6 Industrial Control and Systems Enclosures
  - 3. NEMA ST 1 Specialty Transformers (Except General-Purpose Type)
  - 4. NEMA WC 5 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

**1.05 SUBMITTALS**

- A. Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.
- B. Submit the following submittal information and documents:
  - 1. Schematics and interconnecting drawings;
  - 2. Connection diagrams and outline drawings;
  - 3. Assembly, erection, and installation drawings and manuals;
  - 4. Manufacturer's product and performance data;
  - 5. Operations and maintenance manual for the cathodic protection system;
  - 6. Certificates of Compliance, as required;
  - 7. Test reports; and
  - 8. Parts and special tools lists.

**PART 2 - PRODUCTS**

**2.01 CATHODIC PROTECTION RECTIFIERS**

- A. Rectifiers shall be provided with a minimum of 20 even adjustments, with conveniently accessible taps over the full voltage output range.
- B. The efficiency of each rectifier shall be at least 70 percent. Each rectifier shall be complete with enclosure, transformer, voltage control taps, and necessary appurtenances. Voltage, phase, ac input, and dc output ratings shall be as indicated. The enclosures shall be in accordance with NEMA ICS 6. Sunshades shall be provided for each outdoor rectifier.

- C. Rectifiers shall be enclosed in sheet metal enclosures with welded seams. The enclosures shall be provided with hinged doors. Circuit breakers, ammeters, and voltmeter shall be mounted on an inside panel. The rectifier shall have a ground lug for a minimum of 2/0 AWG ground wire, or as indicated, and shall be suitable for wall or post mounting, with knockouts provided for conduit entrance.
- D. Rectifier semiconductors shall be high current silicon diodes.
- E. Silicon diodes shall be rated to provide adequate margin for over-voltage and over-current surges. They shall be mounted on a heat sink designed to maintain junction temperatures well below manufacturer's recommended maximum temperatures when operating in a 122 degrees F ambient. The rectifier stack shall be single- three-phase, full wave, bridge connected. Silicon diodes shall be protected on input and output sides with zener type selenium surge plates and lightning arrestors.
- F. The transformer shall be a two-winding type with 428 degrees F insulation to operate at rated kVA with a temperature rise not exceeding 270 degrees F above a 122 degrees F ambient. The secondary winding shall have a minimum of four coarse and five fine voltage control taps to provide adjustable output voltages in equal steps over the entire operating range. Voltage control taps shall be stud and link type with removable nuts. The studs and links shall be rated to carry 125 percent of the rectifier full load current. The transformers shall conform to NEMA ST 1.
- G. Each rectifier unit shall have internally mounted meters to read dc current and dc voltage. The ammeter shall be provided with an external shunt. The meters shall be red lined at approximately the three-quarter point of the rectifier unit "full scale" rated value. The meters shall have an accuracy of plus or minus 2 percent.
- H. The main circuit breaker shall be molded case, trip free, flush mounted with toggle handle readily accessible. An overload or short circuit through any single pole shall open all poles simultaneously. The circuit breaker shall conform to NEMA AB 1.
- I. Fuses of the nonrenewable type shall be installed in the secondary side of the rectifier and shall be mounted on the front of the rectifier panel. All wiring shall be in accordance with Section 20 70 26 - Common Materials and Methods for Electrical systems, and Section 26 05 24 - Low Voltage Wires and Cables.

**2.02 IMPRESSED CURRENT ANODES**

- A. High silicon iron chromium anodes shall have the following mineral analysis:

	<u>Element</u>	<u>Percent</u>
1.	Silicon	14.5
2.	Manganese	0.75
3.	Carbon	0.95
4.	Chromium	4.5
5.	Iron	remainder

CATHODIC PROTECTION

- B. For underground piping, the anode shall be high silicon iron chromium, prepackaged in steel canisters. Backfill as specified herein shall be compacted to fill the container. The container top shall be perforated. A strap shall be designed and installed that will support the weight of the package. Container size shall be 22 gage, 10 inches in diameter, 7 feet long.
- C. For underground piping, the anode lead wire shall be protected by a compression washer and a bushing at the top of the container. Anodes shall be provided with epoxy-encapsulated heads with heat-shrink caps. Anode locations and lead wire lengths shall be as necessary.
- D. For underground piping, anode backfill material shall be a tamped calcined coke breeze, screened to provide a particle size from 1/8 inch to 3/8 inch. Resistivity shall not exceed 25  $\Omega$ /cm at a moisture content of 1 percent and a bulk density of 46 to 50 pounds per cubic foot. Composition shall be within the following limits:

	<u>Material</u>	<u>Typical</u>	<u>Guaranteed</u>
1.	Fixed carbon, percent (dry basis)	99.4	99.0 min.
2.	Ash, percent (dry basis)	0.3	0.5 max.
3.	Volatile matter, percent (dry basis)	0.3	0.5 max.
4.	Sulfur, percent (dry basis)	0.8	1.2 max.
5.	Moisture (per Cent)	0.02	1.0 max.

**2.03 ANODE SHUNT JUNCTION BOX**

- A. The enclosure shall be a watertight galvanized steel box complete with terminal blocks, shunts, copper jumpers, and bus bars. Box shall be coated, non-metallic, as approved by the Engineer.
- B. Shunts shall be 0.01  $\Omega$ , 8 A, if high silicon iron chromium anodes are used.

**2.04 BONDING BOXES**

- A. The enclosure shall conform to NEMA ICS 6. Shunts, terminal blocks, and bus bar shall be mounted on the backplate.
- B. Hookup wiring shall be thermoplastic flame retarding in accordance with ASTM D3032.

**2.05 TERMINALS AND TERMINAL BLOCKS**

- A. Connections shall be made with compression type ring tongue or spring spade (locking spade) terminals sufficiently strong to prevent their breakage under the conditions of vibration for which the equipment is designed.

- B. The dc output terminal shall be sized for not less than No. 2 AWG cable. Slotted, flanged spade and hook terminals or terminals of the quick disconnecting type are not acceptable. Crimping tool and terminal blocks shall be provided as necessary. Insulated ferrules shall be provided if adjacent cable terminations permit contact.

**2.06 INSULATING FLANGE KITS**

- A. Insulating gaskets for service up to 175 degrees F shall be ring type, neoprene-faced phenolic. For service up to 250 degrees F insulating gaskets shall be ring type non-asbestos faced phenolic suitable for 250 degrees F.
- B. For insulating sleeves, material shall be high-density polyethylene 1/32 inch thick. Sleeve lengths shall be two flange thicknesses, including raised faces, plus gasket thickness, plus two insulating washer thicknesses, plus steel washer thicknesses. Flange bolt holes shall be oversized.
- C. Two insulating washers and two steel washers for each sleeve are required. The insulating washers shall be linen electric grade, 1/8 inch thick. The steel washers shall be machine cut, deburred, and at least 1-1/4 inches in outside diameter by 11 gage.
- D. Test bolts shall be 1/2-13 UNC by 2 inches silicon bronze cap-screws.

**2.07 SACRIFICIAL ANODES**

- A. Sacrificial anodes shall be magnesium anodes and shall comply with the following chemical requirements:

1.	Aluminum	0.010 percent (max.)
2.	Manganese	0.50 to 1.30 percent
3.	Zinc	0
4.	Silicon	0
5.	Copper	0.02 percent (max.)
6.	Nickel	0.0001 percent (max.)
7.	Iron	0.03 percent max.
8.	Other	0.05 percent max. each or 0.3 percent max. total
9.	Magnesium	Remainder

- B. Anodes shall be cast with a galvanized steel rod core, silver soldered to HMWPE cable, and shall have a net magnesium weight of 20 pounds (Galvomag 20D2). The core weight shall not exceed 0.1 pound per foot.

- C. Anodes shall be contained in a cloth sack with 50 pounds of backfill consisting of 75 percent hydrated gypsum, 20 percent bentonite, and 5 percent sodium sulfate.

- D. The anode lead wire shall be No. 8 AWG, 600 volt HMWPE insulation.
- E. Anode lead wires shall be long enough to permit installation to test stations without use of underground splices.

**2.08 CATHODIC PROTECTION AND BONDING CABLES**

- A. Cathodic protection cables shall be in accordance with NEMA WC 5, high molecular weight (HMW) Type CP polyethylene insulation not less than 7/64 inch thick, with hypalon jacket on anode cables. Insulation material shall be in accordance with ASTM D1248, Type I, Class C, Grade 5. Cables shall have copper stranded conductors, sized as follows:
  - 1. No. 8 AWG for pipe leads to test station boxes.
  - 2. No. 8 AWG from anodes to anode junction boxes.
  - 3. No. 2 AWG for cathodic protection rectifier positive and negative leads to distribution boxes.
  - 4. No. 2 AWG for cast iron pipe mechanical joint bonds.
- B. Splicing of underground cables shall be avoided as much as possible. Where splicing is necessary, provide splice boxes. Splicing of cables shall occur in splice boxes only. Necessary splices and repairs shall be made with cast insulating splice kits acceptable to the Engineer.

**2.09 TEST STATIONS**

- A. Two, three, or four-wire test stations shall be provided. The test stations shall consist of a weatherproof terminal box, NEMA Type 3 R, with removable cover, test lead wires, and five terminals, installed approximately 3 feet above the surface.
- B. Flush type test stations shall be installed. They shall be approximately 4 inches by 18 inches or 5 inches by 18 inches long plastic pipe with heavy cast-iron loading covers and collars suitable for both curb and roadway installations.

**2.10 NAMEPLATES, NAMEPLATE BAR**

- A. Engraved nameplates and nameplate bars shall be provided conforming to the requirements of Section 20 70 26 - Common Materials and Methods for Electrical Systems.

**2.11 ACCESSORIES**

- A. Reference Electrodes: Reference electrodes shall be as indicated.
- B. Potential Stations: Potential stations shall consist of a precast concrete housing or vault that is open at the bottom and shall be furnished with a cast iron traffic cover marked CP on the top of the cover. The station shall be filled to within 3 inches of its top with clean soil.

**PART 3 - EXECUTION****3.01 WELDING**

- A. Welding Procedures: Make connections between copper conductors and metallic piping, and other metal components, by either exothermic welding or brazing, except that brazing will not be permitted on natural gas distribution and transmission facilities. Procedures, materials, and equipment for thermite welding shall conform with the manufacturer's printed welding recommendations. Brazing shall conform to AWS standard practices.
- B. Thermite Weld: For rectifier negative wires and anode wires, when the thermite weld has cooled and the slag has been removed, the weld shall be tested by striking the weld with a two-pound hammer around the weld at an angle of 45 degrees to the surface while pulling on the wire. Remove and replace defective welds with new welds.
- C. Protective Coating: Coat welds with cold-applied mastic or a coating equal to that on the structure, ensuring that bare or exposed metallic areas are coated. Allow adequate time for drying.

**3.02 ANODES**

- A. Install cathodic protection anodes at the locations and in the manner indicated. Route wires from the anodes so as to prevent damage and mechanical stress on the insulation upon backfilling. Inspect insulation on anode wires for damage and approve before backfilling. Replace anodes with damaged wire insulation. Splicing of anode wires will not be permitted. Installation shall conform to NACE RP0169.
- B. Install sacrificial metal anodes at the locations and in the manner indicated. Installation shall conform to NACE RP0169.
  - 1. Wet packaged anode thoroughly before backfilling the hole.
  - 2. Use native soil, free from stones, aggregates, and bricks, for backfilling. Do not use sand or slurry cement for backfill on anodes.
- C. Install anode junction and test boxes of types and at locations indicated.
- D. Connect anode lead wires to header cable or in test boxes as indicated.

**3.03 FIELD QUALITY CONTROL**

- A. Inspection and testing of work associated with the installation of the cathodic protection system shall be performed by the Contractor under the observation of the Engineer.
- B. Provide qualified personnel as required to assist the Engineer in locating the installed test points. Provide as-built details of test point installations.

**3.04 CATHODIC PROTECTION SYSTEM ACTIVATION**

- A. Activation and confirmation of the cathodic protection system shall be performed by the Contractor and verified by the Engineer.
- B. Anodes shall be tested for proper current output and level of cathodic protection provided to piping systems, after installation of anodes and associated wiring and junction boxes, but before final street paving or construction of concrete sidewalks.

**END OF SECTION 26 42 00**