

**SECTION 13110  
CATHODIC PROTECTION**

**PART 1: GENERAL**

1.1 **SCOPE OF WORK**

- A) This section includes materials, testing and installation of corrosion protection and monitoring systems for metallic pipes including insulating flange kits, test stations, sacrificial anodes, wiring, and exothermic welds.

1.2 **RELATED WORK**

- A) Valves, couplings, thrust restraint, hardware, and appurtenances for yard and miscellaneous piping are in Section 02667
- B) Earthwork for pipe installation is in Section 02226.

1.3 **REFERENCE STANDARDS**

- A) The publications listed below form part of this specification to the extent referenced and are referred to in the text by the basic designation only. Reference shall be made to the latest edition of said standards unless otherwise called for.

AWWA 209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C216	Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C217	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines
ASTM D 1248	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable
NACE RP0274	High-Voltage Electrical Inspection of Pipeline Coatings
NACE RPO286	The Electrical Isolation of Cathodically Protected Pipelines

1.4      REQUIRED SUBMITTALS

- A)      Submit manufacturer's catalog data on wire and cable, test stations, exothermic weld molds and charges, pipe flange insulation gasket kits, pipe flange internal coating, tape coating system, plastic warning tape, sacrificial anodes, and any other required materials.

1.5      MANUFACTURERS

- A)      All materials furnished under this specification shall be standard products from manufacturers regularly engaged in the manufacture of such products and shall be the manufacturer's latest design that complies with the specification requirements.

1.6      PIPE JOINT BONDING CABLES

- A)      Electrical continuity bonding cables shall be installed across all buried or submerged metallic inline valves, flexible couplings, grooved couplings, pipe joints that are not circumferentially welded, and all other pipe joints except flange joints equipped with insulating gaskets kits. Where shown on the drawings, bonding cables shall be installed in vaults.

1.7      GALVANIC ISOLATION

- A)      All threaded outlets shall incorporate the use of an insulated ball valve for galvanic isolation of stray current. Threaded outlets may incorporate the use of a nylon isolation bushing for galvanic isolation only with the approval of the Engineer. Where the use of nylon bushings is required, the threaded outlet shall be increased in size to accept the bushing.

1.8      WARNING/IDENTIFICATION TAPE

- A)      All cathodic protection test wires, cables and conduit shall include Warning/Identification Tape installed as indicated on the drawings to act as a warning against accidental excavation.

1.9      QUALITY ASSURANCE

- A)      The CONTRACTOR is responsible for the performance of all inspection and testing requirements as specified within these specifications and the other

referenced standards. The tests shall be performed at no additional cost to the OWNER.

## **PART 2: PRODUCTS**

### **2.1 GENERAL**

- A) Items in this section shall be in accordance with the Approved Drawings.

### **2.2 TEST STATIONS**

- A) Cathodic monitoring test stations shall be above grade, double-conduit, post-mounted with 8 terminals standard, a 0.01 ohm shunt, and a copper bus bar within a locking watertight enclosure.

Flush-mount or at grade installations are acceptable as approved by the Engineer or as shown on the drawings in locations where installation can not be completed according to Part 3 of these specifications. Enclosures must be traffic rated, but otherwise consistent with these specifications.

### **2.3 PREPACKAGED MAGNESIUM ANODES**

- A) Prepackaged magnesium anodes shall be used in low current demand applications. The amount and size of magnesium anodes shall be as shown on the Approved Plans, and shall be installed in accordance with the manufacturer.
  - 1) Prepackaged magnesium anodes shall have galvanized steel rod cores encased in magnesium ingots. The ingot portion of anodes shall be of the weight as required on the Approved Plans.
  - 2) Provide magnesium anodes with minimum No. 12 AWG HMWPE (black) insulated wire. Each lead wire shall be long enough to extend to the corrosion monitoring test station box plus 24 inches of slack without splices.
  - 3) Magnesium anodes shall be prepackaged in a permeable cloth bag with a prepared backfill material which maintains moisture around the anode and lowers the anode to earth resistance.

### **2.4 TEST CABLE AND BONDING CABLE**

- A) All test cable and bonding cable shall be stranded copper wire with insulation rated at 600 volts. Cable with cut or damaged insulation is not acceptable. All

cable shall be of sufficient length to extend from the point of connection to the appropriate corrosion monitoring test station without splices.

- B) The cable shall have a minimum 2.8mm (7/64") thick, high molecular weight polyethylene (HMWPE) insulation specifically designed for cathodic protection service and suitable for direct burial in corrosive soil or water, conforming to ASTM D 1248, Type I, Class C, Category 5 (HMW/PE Type CP) Grade E-5 or J-1.
- C) Test cable shall have at least 24 inches of slack in the test box. Cable size and color coding shall be in accordance with the Approved Drawings.

## 2.5 PIPE FLANGE INSULATING KITS

- A) All pipe flange-insulating materials shall be of the type designated by the manufacturer as suitable for potable water (NSF 61) service at the operating temperatures and pressures of the pipeline.
  - 1) Insulating gaskets shall be full-face, high dielectric, neoprene-faced phenolic or G-10 epoxy glass faced EPDM.
  - 2) Insulating sleeves shall be full-length, G-10, mylar or phenolic
  - 3) Insulating washers shall be 1/8-inch thick, G-10 or phenolic.
  - 4) Steel bolts, nuts, and washers shall be as specified elsewhere or required by the manufacturer of the flange, valve, fitting, or pipe appurtenance.
  - 5) Chemical additives used to prevent the galling of threads must be non conductive.

## 2.6 ADDITIONAL SMOOTH EPOXY LINING AT INSULATED PIPE FLANGES

- A) In addition to the cement mortar lining, the interior of the pipe at all insulated flanges shall be coated with a two-part smooth white liquid epoxy consisting of 100 percent solids suitable for potable water use (NSF/ANSI 61 compliant).

## 2.7 TAPE WRAP FOR ABOVEGROUND INSULATED PIPE FLANGES

- A) All aboveground insulated pipe flanges shall be wrapped with minimum 0.36mm (14 mil) thick general utility pipeline tape.

## 2.8 WAX TAPE COATING FOR BURIED INSULATED PIPE FLANGES

A) All buried insulated pipe flanges shall be coated with a three-part, cold-applied wax tape coating system as described by NACE RPO375 and AWWA C217. Wax tape is also required where indicated on the Approved Plans.

1) Primer: Primer shall be a blend of petrolatums, plasticizers and corrosion inhibitors having a paste-like consistency. The primer shall have the following properties:

Color:	Brown
Pour Point:	37.8° C - 43.3° C (100° - 110° F)
Flash Point:	176.7° C (350° F)
Coverage:	0.41 L/M2 (1 gal/100 sq. ft.)

2) Wax Tape: Wax tape shall consist of a plastic-fiber felt, saturated with a blend of petrolatums, plasticizers, and corrosion inhibitors, forming a tape coating that is easily formable over irregular surfaces. The tape shall have the following properties:

Color:	Brown
Saturant Pour Point:	46.1° C - 48.9° C (115° - 120° F),
Thickness:	1.27 - 1.78 mm (50 - 70 mils)
Tape Width:	150mm (6")
Dielectric Strength:	170 volts/mil

3) Tape Outerwrap: Wrapper shall be a polyvinylidene chloride plastic with three 50-gauge plies wound together as a single sheet. The wrapper shall have the following properties:

Color:	Clear
Thickness:	0.0381 mm (1.5 mils)
Dielectric Strength:	2000 volts/mil
Tape Width:	150mm (6")
Water Absorption:	Negligible

## 2.9 EXOTHERMIC WELD MOLDS AND WELD CHARGES

A) Wire-to-pipe connections shall be made using exothermic welds. Weld charges and mold sizes for various surface configurations and materials shall be in accordance with the manufacturer's recommendations.

## 2.10 REPAIR COATINGS FOR EXOTHERMIC WELDS

- A) A thermite weld cap or approved other and appropriate primer and mastic is required at all wire to pipe connections. Additional coatings repair as necessary shall be in accordance with the repair material described in Section 02617.

#### 2.11 BRASS IDENTIFICATION TAGS

- A) All wires terminating in Cathodic Protection (CP) Test Boxes shall be identified with brass tags securely attached to the wires with nylon fasteners. The tags shall be 38mm (1½") in diameter, 1.6mm (1/16") thick, and shall be die-stamped with identifying letters and numbers 6.4mm (¼") high as shown on the Approved drawings.

#### 2.12 WARNING/IDENTIFICATION TAPE

- A) Warning/Identification tape shall be an inert (non-detectable) plastic film, 150 mm (6-inches) wide, formulated for prolonged underground use, puncture-resistant, and shall have an elongation of two times its original length before parting.
- B) The tape shall be colored: red, the printed message shall be: "CAUTION: CATHODIC PROTECTION CABLE BURIED BELOW" and the ink used to print the message shall be permanently fixed to the tape and be black in color.

#### 2.13 CONCRETE

- A) Concrete used for the construction of the test station box shall be normal strength mix (minimum compressive strength of 3000 psi) and shall include minimum steel reinforcement as indicated on the Approved Drawings.

### **PART 3: EXECUTION**

#### 3.1 CATHODIC PROTECTION TEST STATIONS

- A) All test stations shall be installed behind existing or proposed curbs or otherwise out of traffic lanes to allow safe access for personnel during testing in accordance with the Approved Drawings. A utility marker post shall be installed when indicated on the Approved Plans.

#### 3.2 EXOTHERMIC WELDS

- A) All cable-to-pipe connections shall be made using exothermic welds in accordance with the Approved Drawings.

- 1) Preparation of Cable: Cut cable with a wire cutter to prevent deforming the cable ends. Remove only enough insulation from the cable to allow the weld connection to be made.
- 2) Preparation of Pipe: The surface of the steel or ductile-iron pipe shall be ground or filed to a bright, shiny, clean and dry surface before welding the cable connection.
- 3) Attachment of Cable to Structure: The attachment of the cable to the structure shall be made using an exothermic weld. The cable shall be held at a 30° to 45° angle to the surface when welding. Only one cable shall be attached with each weld. All cable-to-pipe welds shall be a minimum of 75mm (3") apart. All weld slag shall be removed from the weldment with a wire brush.
- 4) Weldment Test: After the exothermic weld has cooled, the weld shall be tested by the Contractor for strength, in the presence of the Engineer, by striking the weldment a sharp blow with a 0.91 Kg (2 lb.) hammer while pulling firmly on the cable. All unsound welds shall be re-welded and retested.
- 5) Repair Coatings: The area to be repaired shall be thoroughly clean and dry. A weld cap or approved other and appropriate primer and mastic shall be installed per manufacturer's recommendations at each wire to pipe connection. Pipe coatings shall be repaired or replaced to original condition using a tape coating system (AWWA C209) as indicated in Section 02617 and as directed by the Engineer.

### 3.3 PIPE FLANGE INSULATING KITS

- A) Pipe flange insulating kits shall be installed at the locations shown on the Approved Plans and in accordance with the specifications and the manufacturer's recommendations.
- B) Insulation shall also conform to the National Association of Corrosion Engineers' Recommended Practice RPO286 "Electrical Isolation of Cathodically Protected Pipelines".
- C) Particular attention shall be paid to properly align the pipe flanges prior to inserting the bolts with insulating sleeves to prevent cutting of the sleeves and creating an electrical path when the bolts are tightened.

- D) Care shall be taken to prevent any moisture, soil, or other foreign matter from contacting any portion of the two mating pipe flanges or gaskets prior to or during installation. If any foreign matter contacts any portion of the insulated pipe flange, the entire pipe joint shall be disassembled, cleaned with a suitable solvent and dried prior to reassembly.
- E) Strictly follow the manufacturer's recommendations regarding the torque pattern of the bolts and the amount of torque to be used when installing the pipe flange insulating kit.
- F) Conductive grease shall not be used on the flange bolts or any other flange components under any circumstances. Refer to Field Testing below for testing of the flange insulation kits.

#### 3.4 ADDITIONAL MORTAR LINING AT INSULATED PIPE FLANGES

- A) At all insulated pipe flanges, additional cement mortar lining shall be applied. The interior of the pipe and flanges shall be coated with the lining for a distance of two pipe diameters in each direction away from the insulated pipe flange.
  - 1) Surface Preparation: The surface preparation shall consist of wire brushing to remove all rust and scale and to provide a suitable surface for adhesion of the coating in accordance with the manufacturer's recommendations.
  - 2) Mixing: The cement mortar lining shall be mixed per the manufacturer's recommendations thoroughly before being applied.
  - 3) Applying: The application of the lining shall be made by trowelling and forcing the mix into the jointed area until a minimum dry film thickness (DFT) of 2 mm (80 mil) is achieved.

#### 3.5 WAX-TAPE COATING FOR BURIED INSULATED PIPE FLANGES

- A) After continuity testing, all flange and pipe surfaces shall be clean and free of all dirt, grease, water or other foreign material prior to the application of the primer, wax tape, and tape outerwrap.
  - 1) Apply primer by hand or brush to all surfaces of the flanges. Work the primer into all crevices, around bolts and nuts, and completely cover all exposed metal surfaces. Extend the primer a minimum of 75mm (3") onto adjacent surfaces of the pipe or valve.



- 2) Apply the wax tape immediately after the primer application. Cut short lengths of tape and place completely around each bolt head and nut. Work the tape into the crevices around the bolts and nuts. Wrap the wax tape spirally around the pipe and across the flanges to the other pipe or valve. Cover the entire primed area with wax tape using a minimum overlap of 55% of the tape width. Work the tape into the crevices and contours of the irregular shaped surfaces and smooth out so that there is a continuous protective layer with no voids or spaces under the tape.
- 3) Apply the tape outerwrap to the completed wax tape installation. Wrap spirally around the pipe and across the flanges. Extend the plastic wrap 75mm (3") past the wax tape using a minimum overlap of 55% of the plastic material width to apply two layers of overwrap.

### 3.6 PREPACKAGED MAGNESIUM ANODES

- A) Prepackaged magnesium anodes shall be placed a minimum of 1.8m (6') below and adjacent to the pipe in the trench or an augured hole. Soaking of the anode may be required by manufacturer. Backfill material around the prepackaged anodes shall be as specified for the pipeline trench. Installation shall be in accordance with the Approved Drawings.

### 3.7 TEST CABLE

- A) All buried test cable requiring trenching to the test station box location shall be installed, without splices, in a conduit in the trench at a minimum depth of 600mm (24"). Trenches shall be compacted in accordance with Section 02226. Care shall be taken when installing wire and backfilling trench to prevent damage to the installation. Damaged wire shall be replaced in entirety.

### 3.8 WARNING/IDENTIFICATION TAPE

- A) Warning/Identification Tape shall be installed in accordance with these specifications and the Approved Drawings.

### 3.9 BRASS IDENTIFICATION TAG

- A) Brass identification tags shall be used to identify all cables in all test boxes. Care shall be taken to accurately maintain the wire identities. The tags for all test cables shall be stamped with the District name, the pipeline size, the contents of the pipeline, and the direction of the connection point along the pipe, in accordance with the Approved Drawings. The tags shall be securely attached to each wire with nylon fasteners prior to pipe backfilling operations.

### 3.10 FIELD TESTING

- A) The CONTRACTOR shall test the cathodic protection installations in the presence of the Engineer. CONTRACTOR shall notify Engineer of proposed test dates and times a minimum of 48 hours in advance. As a practical approach, the CONTRACTOR may choose to verify pipe continuity and flange isolation (described in Items A and B below) prior to backfilling as an unofficial test. Official testing shall occur after the backfilling and installation of the test boxes.
- 1) Pipeline Electrical Continuity Testing: Test the electrical continuity of all sections of pipe to be monitored between each pair of adjacent cathodic protection monitoring test stations or between the ends of pipe sections less than 152.4m (500') apart. Each pipe section shall be considered electrically continuous when the measured longitudinal resistance of each pipe section is no greater than 20% higher than the theoretical resistance of that section of pipe. If testing indicates inadequate electrical continuity, the CONTRACTOR shall excavate to investigate and locate improperly bonded pipe joints and make repairs until electrical continuity is accomplished to the satisfaction of the Engineer.
  - 2) Insulated Pipe Flange Testing: Each insulated pipe flange will be tested for effective electrical isolation of the two mating pipe flanges. The insulated pipe flange shall be judged for effectiveness in accordance with NACE RPO286, Section 7, Field Testing and Maintenance." The Contractor shall replace or repair any insulated pipe flange assembly until electrical discontinuity is accomplished.
  - 3) Initial Reference CP Potential Measurements: The entire metallic piping system shall be tested to establish the base CP Potential measurement readings. The base data will be used for comparative purposes with future monitoring data. The baseline data shall include voltage measurements (+/- 1mV) between any permanent copper sulfate reference electrodes (+ voltmeter correction) and a reliable portable copper sulfate reference electrode (- voltmeter correction) placed directly in the CP test box.

### 3.11 CATHODIC TESTING REPORT

- A) At the completion of the testing, a report of the results will be prepared and presented to the Engineer. The report shall be typed and shall include, at a minimum, test locations, date of tests, name of technician, testing methods, voltage measurements, and theoretical and calculated resistance.

END OF SECTION