SECTION 13110

CATHODIC PROTECTION SPECIFICATION

PART 1. GENERAL

1.1 SUMMARY

A. The work included under this section includes providing all labor, materials, equipment, tools, and incidentals required for the installation of a complete corrosion control system.

B. The Contractor shall be responsible for the procurement, installation, testing, and commissioning of the corrosion control system as specified in this section.

C. The corrosion control system shall consist of the following major components:

1. Basic Corrosion Monitoring System:

   The Contractor shall install and test a system for the monitoring of corrosion potential on the installed pipeline. Provision of the basic corrosion monitoring system will be considered a part of the bid package, and will be included in the Contractor's unit price for pipe material and installation.

2. Galvanic Anode Cathodic Protection System:

   The Contractor shall procure and install a galvanic anode cathodic protection system according to these specifications, plans, and details. The installation of the galvanic anode system will be considered a part of the bid package, and will be included in the Contractor's unit price for pipe material and installation.

D. Reference Standards

The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

   a. B843, Standard Specification for Magnesium Alloy Anodes for Cathodic Protection

   b. G97, Standard Test Method for Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications.

   c. STP 741, Underground Corrosion, a Statistical Probability Method for Soil Resistivity Determination.

   d. G57, Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method.

   e. C94, Standard Specification for Ready-Mixed Concrete.

   f. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field

   g. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

h. A48 Class 25, Standard for Gray Iron Castings.

i. B418, Standard Specification for Cast and Wrought Galvanic Zinc Anodes.

2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

3. National International (NACE) SP0169 – Corrosion Control of Underground Pipelines.

4. National Electrical Manufacturer Association (NEMA) WC 70, Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy

5. US Department of Transportation (DOT) H-20, Load Rating Designations

6. American Water Works Association (AWWA) C110, Ductile-Iron and Gray-Iron Fittings.

1.2 SUBMITTALS

A. Action Submittals

1. Manufacturer's data, including catalog information, material specification, and other information for products to be used.

2. Layout of the basic corrosion monitoring system shall be included with pipeline shop drawings or lay schedule.

3. Corrosion specialist qualifications. The Contractor shall submit the credentials of the proposed cathodic protection or corrosion specialist as part of the shop drawing review process.

B. Informational Submittals

1. Compliance Statement: provide compliance statement that galvanic anode composition meets chemical requirements specified herein.

2. Field test reports to be completed and submitted to Owner with 14 calendar days of testing.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: provide anodes and reference electrodes packaged in a plastic or heavy paper bag of sufficient thickness to protect backfill, and cloth bag during normal shipping and handling.

B. Store prepackaged anodes off the ground to keep them dry. Protect against weather, condensation, and mechanical damage. Immediately remove wet or mechanically damaged prepackaged anodes from site. Handle anodes with care to prevent loss of backfill material. Do not lift or hold anodes by lead wire.

1.4 DEFINITIONS

A. Ferrous Metal Pipe: pipe made of steel or iron, and pipe containing steel or iron as a principle structural material.

B. Lead, Lead Wires, Joint Bonds, Cable: insulated copper conductor; the same as wire.

C. NACE: NACE International

D. CPS: Cathodic Protection or Corrosion Specialist

E. CP: Cathodic Protection

F. AWG: American Wire Gauge, standardized wire gauge system

G. ANSI: American National Standards Institute

H. HMWPE: High Molecular Weight Polyethylene, type of wire insulation.

I. THWN: Thermoplastic Heat and Water-resistant Nylon-coated, type of wire insulation.

J. RHH-RWH: Rubber insulation and heat resistant, type of wire insulation.

PART 2. PRODUCTS

2.1 BASIC CORROSION MONITORING SYSTEM

A. Wires

1. Conform to applicable requirements of NEMA WC 70.

2. Joint Bond:

a. General:

1) Stranded copper wire with 600-volt HMWPE insulation. Supply joint bonds complete with formed copper sleeve on each end of wire.

b. DIP:

1) Wire size for bonding joints shall be as follows:

a)	Main Size	Wire Size
b)	Larger than 36 inches	AWG #2 HMWPE
c)	16 inches to 36 inches	AWG #4 HMWPE
d)	12 inches to small	AWG #6 HMWPE

c. Steel Pipe:

1) Push-On, Mechanical, or Flanged Joints:

a)	18-inches long	#4 AWG wires

2) Flexible Coupling Joints:

a)	24-inches long	#4 AWG wires

3. Anode Header Cable: single-conductor, #8 AWG stranded copper wire with 600-volt HMWPE insulation.

4. Insulation Colors:

    a. Galvanic Anodes: red

    b. Pipeline Test Wires: black (new pipeline) and white (existing pipeline)

    c. Reference Electrodes: blue

    d. Insulated Joints: as shown

B. Cathodic Protection Test Station

1. Flush Mounted:

    a. All test stations shall be flush mounted type unless otherwise shown on project drawings. The test box shall pass US DOT H-20 roadway load test.

2. Raised Test Station:

    a. When test station is out of the road, use a green riser protected by bollards. Cathodic protection monitoring stations shall be a non-metallic post-type station mounted on a non-metallic conduit post, Cott Big Fink® or equal, 5 terminals and 3 terminals.

    b. The test station shall be constructed as follows:

        1) Terminal Board: Polycarbonate Lexan plastic.
        2) Terminal Posts: Nickel-plated marine brass (5 terminal)
        3) Conduit Post: Green, 3-inch diameter UV stabilized polyethylene.

3. Test Station Wires:

    a. Stranded conductor, #10 AWG stranded copper with 600-volt rated THWN insulation. Wires shall be color coded per Section 2.01 A.4.b. of this document.

C. Buried Reference Electrodes

Prepackaged Copper-Copper Sulfate Reference Electrodes:

1. Material: permanent type, copper-copper sulfate reference electrode suitable for direct burial with a minimum design life of 30 years. Electrode shall be prepackaged in a cloth bag containing a low resistivity backfill.

2. Wire: #14 AWG stranded copper wire with blue, 600-volt HMWPE or RHH-RWH insulation. Wire shall be attached to electrode and insulated with manufacturer's standard connection. Connection shall be stronger than the wire. No splicing of the reference electrode lead wire shall be permitted under any circumstances.

3. Acceptable Manufactures:

    a. Borin Manufacturing; model SRE-007-CUY.

    b. Electrochemical Devices, Inc.; model UL50-CUG-CW.

    c. GMC Electrical, Inc.; model CU-1-UGPC.

D. Thermite Weld Materials

1. General:

a. Thermite wire sleeves, welders, and weld cartridges according to manufacturer's recommendations for each wire size, pipe or fitting size, and material.

b. Welding materials and equipment shall be the product of a single manufacturer. Interchanging materials of different manufacturers will not be acceptable.

2. Molds: graphite. Ceramic "One-Shot" molds are not acceptable.

3. Cartridges:

a. General:

1) Maximum cartridge size as recommended by manufacturer

b. DIP:

1) Cast-iron thermite-weld cartridges for cast and ductile iron pipe and fittings.

c. Steel Pipe:

1) Carbon steel thermite weld cartridges for steel pipe and fittings.

4. Welding Materials Manufacturers:

a. Erico Products Inc. (Cadweld), Cleveland, OH.

b. Continental Industries, Inc. (Thermo-Weld), Tulsa, OK.

5. Thermite Weld Caps:

a. Prefabricated weld cap with coating and suitable primer.

b. Handy Cap II with Royston Primer 747, as manufactured by Royston Laboratories, Inc.

c. Equivalent approved by HRSD.

E. AC Ground Mat

1. Zinc ribbon anodes shall be 1/2-inch x 9/16-inch in accordance with the specific project requirements.

2. The anode shall be continuously extruded over a steel wire core of 0.13-inch centrally located in the zinc alloy.

3. The zinc alloy shall meet the requirements of ASTM B418, Type II.

F. Ancillary Materials

1. Compression Connectors:

a. For in-line, tap, and multi splice compression connectors furnish “C” taps made of conductive wrought copper, sized to fit wires being spliced.

b. Manufacturer and Product: Burndy; type YC, or equivalent.

2. Ring Terminal Wire Connectors: one-piece, tin-plated crimp-on lug connector as manufactured by Burndy Co., Thomas and Betts, or equivalent.

3. Splicing Tape: linerless rubber high-voltage splicing tape suitable for moist and wet environments; Scotch 23 rubber splicing tape and Scotch 33+ super vinyl electrical tape, as manufactured by 3M Products, or equal.

4. Electrical Coating Compound: the electrical coating compound shall be a brush applied material formulated for sealing vinyl tape. The electrical coating compound shall be Scotchkote Electrical Coating as manufactured by the 3M Company, or equal.

5. Shunts: 0.01-ohm shunt**.** Test station shunts shall be constructed to fit the terminal posts for the specified test station. The resistance shall be 0.1-ohm with a current capacity of 2-amperes. The shunt shall be as manufactured by Cott Manufacturing Company Model "Yellow" or equivalent.

6. Earth Fill: native soil free of roots and other organic matter, ashes, cinders, trash, debris, and rocks conforming to the project specification for final backfill.

G. Concrete

1. Materials: poured concrete for the flush-mounted test station slabs shall be ready-mix conforming to ASTM C94. Minimum allowable 28-day compressive field strength shall be 3,000-psi when cured and tested in conformance with ASTM C31 and ASTM C39. Portland cement shall be Type 1.

2. Mixing: in a clean metal container, mix entire package of dry materials by hand or machine. Following manufacturer’s instructions, add clean water in sufficient quantity to produce a slump of 2 to 3 inches.

H. Insulating Joints

1. Flange Insulating Kits:

a. General:

1) Provide standard flange diameter bolt hole sizes.

2) Gaskets: full-face type E, G-10 retainer with a quad ring elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.

3) Insulating Sleeves: full-length fiberglass reinforced epoxy (NEMA G-10 grade**)**.

4) Insulating Washers: fiberglass reinforced epoxy (NEMA G-10 grade).

5) Steel Washers: plated, hot-rolled steel, 1/8-inch thick.

a) Provide 2 washers per bolt for flange diameters equal to or less than 36-inch diameter.

b) Provide 4 washers per bolt for flange diameters larger than 36-inch diameter.

6) Manufacturers:

a) Pipeline Seal and Insulator, Inc. (PSI), Houston, TX.

b) Advance Products and Systems, Lafayette, LA.

c) Equivalent approved by HRSD.

b. DIP:

1) Fasteners: in accordance with AWWA C110, for ductile iron pipe. Minimum bolt length shall be the sum of the mating flange maximum thicknesses, sealing gasket, insulating and steel washer thickness, and depth of the nut plus 1/8-inch minimum before torqueing. Since insulating sleeves may not fit over unthreaded portions of fasteners, bolts shall be cut thread full body or threaded rod as required to meet the inside diameter dimensions of the insulating sleeves specified herein.

c. Steel Pipe:

1) Fasteners: in accordance with AWWA C-208-Dimensions for Fabricated Steel Water Pipe Fittings. Minimum bolt length shall be the sum of the mating flange maximum thicknesses, sealing gasket, insulating and steel washer thickness, and depth of the nut plus 1/8-inch minimum before torqueing. Since insulating sleeves may not fit over unthreaded portions of fasteners, bolts shall be cut thread full body or threaded rod as required to meet the inside diameter dimensions of the insulating sleeves specified herein.

2. The insulating corporation valves (stops) shall consist of a brass fitting with a nylon insulator. The insulated corporation ball valve shall be manufactured by Ford Meter Box Company. The corporation valve shall be model FB600 and the insulator adaptor shall be as follows:

a. 3/4-inch service: SI-C04-33-AWT

b. 1-inch service: SI-C04-44-AWT

c. 1-1/2-inch service: SI-C04-66-AWT

d. 2-inch service: SI-C04-77-AWT

3. Insulating Unions: O-ring sealed with molded and bonded insulating bushing to union body. Unions shall be manufactured by Central Plastics Co., Shawnee, OK, or equivalent.

2.2 GALVANIC ANODE CATHODIC PROTECTION SYSTEM

A. Galvanic Anodes

1. Magnesium Anodes:

a. Composition: high potential magnesium, ASTM B843. The composition of the high potential anode shall be as follows:

1) Aluminum 0.010% Maximum

2) Manganese 0.50 to 1.30%

3)	Copper	0.02% Maximum	
4)	Nickel	0.001% Maximum	
5)	Zinc	0.05% Maximum Iron	0.03% Maximum
6)	Silicon	0.05% Maximum	
7)	Other	0.05% each	
8)	Magnesium	Remainder	

b. Open circuit potential and electrochemical capacity:

1) Open Circuit Potential: negative 1.70-volts or more negative to a copper-copper sulfate reference electrode.

2) Electrochemical Capacity: 490-ampere-hours per pound at 50% efficiency, minimum.

3) As determined by laboratory testing using ASTM G97.

c. Dimensions: Ingot dimensions shall be 5.5-inch x 19.875-inch, type 32D5. Final dimensions of the backfill and anode shall be 8-inch x 28-inch.

d. Weight: bare ingot weight shall be 17-pounds. Final weight of the anode and backfill shall be 45-pounds.

2. Wire-to-Anode Connection: manufacturer's standard. Anode connection shall be stronger than the wire. A minimum of 20-feet of #12 AWG solid copper wire with THWN insulation (red) shall be attached to the anode. Wire to anode attachment shall be by silver solder and sealed to prevent any moisture penetration.

B. Backfill

1. Composition:

a.	Ground Hydrated Gypsum	75%
b.	Powdered Wyoming Bentonite	20%
c.	Anhydrous Sodium Sulfate	5%

2. Grain Size: 100% passing through a 20-mesh screen and 50% retained by a 100-mesh screen.

3. Mixture: thoroughly mixed and firmly packaged around galvanic anode within cloth bag by means of adequate vibration.

4. Quantity of backfill shall be sufficient to cover surfaces of anode to a depth of 1-inch.

PART 3. EXECUTION

3.1 GENERAL

A. Construct pipe bonding system, test stations, electrical isolation and galvanic anode cathodic protection system on buried steel, ductile iron and cast iron, and appurtenances.

B. Conform to NFPA 70.

C. CPS shall observe installation of, or inspect following installation, all equipment required by this section. CPS to provide written certification of successful installation.

3.2 BASIC CORROSION MONITORING SYSTEM

A. Pipe Joint Bonding:

1. General:

a. Electrically bond all pipe joints, including vault and manhole piping and fittings, and including restrained joints, except joints specified to be threaded, welded, or insulated.

b. Number of Bonds per Joint:

1) Install 2 joint bond wire assemblies at each joint that requires bonding, as shown on project details.

c. Use thermite weld process for electrical connection of wires to pipe and fittings.

1) When the weld has cooled, remove the weld slag and test the weldment for strength by striking a sharp blow with a 2-pound hammer while pulling firmly on the wire. Re-weld unsound welds and retest weldments. Thoroughly clean mold and mold covers after completion of each weld to assure that no slag will penetrate the next weld.

d. After soundness of the weld has been verified, thoroughly clean with a stiff wire brush and coat.

1) Thermite welds to ductile iron and steel pipe and fittings, steel bonding plates on ductile iron and steel pipe, and steel casings shall be coated with a plastic cap filled with elastomeric material. The elastomeric cap shall extend on all 4 sides beyond the cleaned area. Apply primer over the entire weld area and over the entire area where the elastomeric cap will be placed. Push the dome of the prefabricated cap containing elastomeric material firmly into weld area. Lift the wire away from the pipe and apply the elastomeric material completely around and underneath the wire. Push the wire back down on the pipe. Follow all manufacturers' instructions for installing prefabricated caps. For coated pipe and fittings, repair any and all external coatings that are removed or damaged during the thermite welding.

e. Test each bonded joint for continuity.

f. Bronze wedges are not an acceptable method of achieving electrical continuity.

2. DIP:

    a. Thermite welds to ductile pipe shall be coated with a minimum of 10-mils of a brush-applied mastic. The mastic shall cover the entire area of the weld and the steel bonding plate. The mastic shall be allowed to completely dry before fully embedding within concrete mortar at the pipe joint. Follow all manufacturers' instructions for applying mastic coating.

3. Steel Pipes:

    a. All the bonding cables should be installed at bonding plate on the pipeline.

B. Wire Insulation Repair

    a. Repair splices or damage to wire insulation by spirally wrapping (50% overlay, minimum) with 2 coats of splicing tape and 2 layers of vinyl electrical tape. Make wire splices with suitable sized compression connectors or mechanically secure and solder with rosin cored 50/50 solder. Splices shall be approved by Engineer.

C. Test Station Installation

1. CPS to determine location of test stations based on actual site conditions and as shown on project plans.

2. Attach test wires to pipe via thermite weld connections. Cover with coating material as specified.

3. Test wires connected to foreign-owned pipelines shall be approved in writing by the operator of the pipeline. Wires to foreign-owned pipelines will be attached by pipeline owner. Coordinate this work with owner of foreign pipeline before pipe is excavated.

4. Locate flush mounted test stations to side of street, behind curb.

5. Install all flush mounted test stations in a 12-inch x 12-inch x 3-inch deep reinforced concrete pad in unpaved areas.

6. Locate post mounted test stations as dictated by field conditions and as approved by the Engineer.

7. Reference Electrode Installation:

    a. Place reference electrode within pipeline trench excavation 6-inches from centerline of pipe in a vertical or horizontal position. Install reference electrode within 12-inches of foreign pipelines or as directed by Engineer, between foreign and owner's pipeline.

    b. Backfill reference electrodes with native trench material. Terminate wires in test stations.

    c. Bury test and reference electrode wires a minimum of 36-inches below finished grade.

    d. Make wire connections to test station terminals with crimp-on spade lug terminals, except where solid wire is specified or terminal strips with tubular clamps are used.

8. Wire Labels:

    a. Install on conductors in boxes.

    b. Materials shall be suitable for permanent identification.

c. Plastic, paper, or cloth markers will not be permitted.

d. Position markers in boxes so they do not interfere with operation and maintenance.

e. Each pipe test wire shall include pipe diameter and pipe type, reference electrode, casing, or galvanic anode, as applicable.

D. Concrete

1. Concrete shall be Class B as specified.

2. Reinforcing shall be as specified.

E. Insulated Joints

1. Install insulated joints to electrically isolated pipeline from other structures. Locate insulated joints at connections to existing metallic pipe, where cathodically protected pipe connects to pipe not intended to have cathodic protection, and where shown. Install a 4 wire test station at each buried insulated joint as shown on the project drawings.

2. Align and install insulating joints according to manufacturer's recommendations to avoid damaging insulating materials. Torque all flange isolation kits to the manufacturer recommended torque ratings, careful not to over torque the bolts.

3. Before backfilling, the Contractor shall test each insulator for electrical insulation. If the insulator is not properly isolated, the Contractor shall, at his expense, repair or replace all defective components. The Contractor shall test the repaired insulator. This process will continue until the insulator is tested to be properly isolated. Insulation that passes for effective isolation during the pre-backfill test, but does not render positive isolation results during the acceptance testing must be repaired by the Contractor at no additional cost to the Owner. The Contractor shall provide the Engineer a minimum notice of 5 business days prior to the conducting the testing of the isolation.

F. Insulated Joint Testing:

1. Test each insulation joint after assembly CPS shall monitor the tests. Contractor shall replace damaged or defective insulation parts at no cost to the Owner.

2. Correct defects identified during testing.

3. Provide Engineer with 5 business days' notice before beginning tests.

Acceptance criteria are as follows:

a. High Frequency Isolation Tester: "Acceptable", "Satisfactory" or other similar direct meter reading, and

b. Electrical Potential: static potential difference across insulator of no less than 0.1 volt, and

c. Electrical Potential/Applied Current: a positive potential shift on the side of the insulator where current is applied, and a negative potential shift on the side of the insulator opposite of where current is applied.

3.3 GALVANIC ANODE CATHODIC PROTECTION SYSTEM

Galvanic Anode Installation:

A. Install galvanic anodes at locations as shown on the project drawings.

B. Alternate anode placement on opposite sides of pipe.

C. Provide minimum anode spacing of 2-feet from other unprotected pipelines.

D. Thoroughly compact earth-fill around each anode to a point 1-foot above anode. Stop backfill below grade to allow for placing of topsoil, when required.

E. Bury anode wires a minimum of 24-inches below finish grade.

3.4 FIELD TESTING

A. General:

1. Provide CPS to visit site throughout installation of the basic corrosion monitoring system including, pipe joint bonds, insulating flanges and couplings, test stations, reference electrodes, and other system components. CPS shall be responsible for certifying compliance with these specifications, and for observation and testing services. Certification shall be submitted to the Engineer and Owner for the project record.

2. The CPS shall visit the site during the installation of the galvanic anode system and shall be responsible for certifying compliance with these specifications and the design provided. Certification shall be submitted to the Owner and Engineer as part of the project record.

3. Energizing and Testing: provide Engineer with 5 working-day notices before beginning tests. After installation of the cathodic protection system is complete, the CPS shall connect anodes to pipe in test stations, where applicable, and make sufficient tests to ensure proper installation of cathodic protection system. Upon completion of such tests, the CPS who conducted the tests shall tabulate and report the data recorded. In addition to the field data tabulations. CPS shall include in his report recommendations for system maintenance and monitoring.

4. Electrical Continuity Tests

   a. Provide necessary equipment and materials and make electrical connections to pipe as required to test continuity of bonded joints.

   b. Conduct continuity test on buried joints that are required to be bonded. Test electrical continuity of joint bonds after bonds are installed but before backfilling of pipe.

   c. Have CPS monitor tests of bonded joints.

   d. Test electrical continuity of completed joint bonds using a digital low resistance ohmmeter.

   e. Digital Low Resistance Ohmmeter Method:

      1) Provide the following equipment and materials:

         a) Digital low resistance ohmmeter.

b) 1 set of duplex helical current and potential hand spikes, cable length as required

c) 1 calibration shunt rated at 0.001-ohms, 100-amperes.

5. Test Procedure: measure resistance of joint bonds with low resistance ohmmeter in accordance with manufacturer's written instructions. Use helical hand spikes to contact pipe on each side of joint, without touching thermite weld or bond. Clean contact area to bright metal by filing or grinding and without surface rusting or oxidation. Record measured joint bond resistance on test form described herein. Repair damaged pipe coating.

B. Joint Bond Acceptance:

1. DIP:

a. Joint Bond Resistance: the maximum acceptable span resistance shall be 115% or less of the summation of the following:

1) Number of pipe joints multiplied by the theoretical resistance of a joint bond.

2) Number of pipe segments multiplied by the resistance per pipe segment. Replace joint bonds that exceed the allowable resistance. Retest replacement joint bonds for compliance with bond resistance.

b. Repair any defective joint bonds discovered during energizing and testing. All repairs for defective joint bonds shall be completed at no cost to the Owner.

1) Record Tests of Each Bonded Pipeline.

2) Description and location of pipeline tested.

3) Starting location and direction of test.

4) Date of test.

5) Joint type.

6) Measured joint bond resistance (digital low resistance ohmmeter method only).

C. Insulated Joint Testing:

1. DIP:

a. Test each insulation joint after assembly. CPS shall monitor the tests. Contractor shall replace damaged or defective insulation parts at no cost to the Owner.

b. Correct defects identified during testing.

c. Provide Engineer with 5 business days advance notice before beginning tests.

d. Acceptance criteria are as follows:

1) High frequency isolation tester: "Acceptable", "Satisfactory" or other similar direct meter reading, **and**

2) Electrical potential: Static potential difference across insulator of no less than 0.1 volt, **and**

3) Electrical potential/applied current: A positive potential shift on the side of the insulator where current is applied, and a negative potential shift on the side of the insulator opposite of where current is applied.

D. Test station wiring acceptance criteria shall be as follows:

1. Test wires attached to ductile iron and steel piping and/or portable copper/copper sulfate reference electrode. Adjacent test wires on piping shall also have identical potential values.

2. Test wires attached to concrete piping shall have potentials between -0.20 and -0.50 volts to a portable copper/copper sulfate reference electrode. Adjacent test wires on piping shall also have identical potential values

3. Magnesium anode header cables shall have a potential between -1.55 and -1.65 volts to a portable copper/copper sulfate reference electrode. Both ends of the magnesium anode header cable shall also have identical potential values.

4. Permanent copper/copper sulfate reference electrodes shall have a potential between -0.05 and +0.05 volts to a portable copper/copper sulfate reference electrode.

3.5 AS-BUILT DATA

A. Documentation of the location, class, type, and all additional pertinent asset data shall be integrated into project as-built records submitted to Owner.

3.6 CLEAN-UP

A. The Contractor shall be responsible for clean-up and removal of all debris, extra material, and equipment utilized for installation of the corrosion control/corrosion monitoring system.

END OF SECTION