

Section 16645

AC INTERFERENCE MITIGATION SYSTEMS FOR PIPELINES
GRADIENT CONTROL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

This Section includes:

- A. AC mitigation materials and installation requirements for gradient control mat systems on water pipeline projects.
- B. Locations requiring AC mitigation are - test stations or other above grade pipeline apparatus such as valves, risers or any other exposed metal pipeline parts, associated with coated carbon steel or polyethylene encased ductile iron piping paralleling or crossing high voltage power transmission lines, that are required to have gradient control mats per the AC interference mitigation design.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices

No payment will be made for AC mitigation for pipelines under this section. Include cost in unit price for water mains or sewers.

1.03 REFERENCES

- A. Institute of Electrical and Electronics Engineers (IEEE) Standard 80, Guide for Safety in AC Substation Grounding. IEEE, New York, New York, August 2000.
- B. ASTM B418 – Standard Specification for Cast and Wrought Galvanic Zinc Anodes
- C. NFPA 70, National Electrical Code
- D. NACE P0177-2014, Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems
- E. CSA Standard CAN/CSA-C22.3 No. 6-M91, Principles and Practices of Electrical Coordination Between Pipelines and Electrical Supply Lines
- F. European Standard CEN/TS 15280, Evaluation of A.C. Corrosion Likelihood of Buried Pipelines – Application to Cathodically Protected Pipelines.
- G. UL 83, Thermoplastic Insulated Wires

- H. UL 467, Bonding and Grounding Equipment
- I. UL 486A, Wire Connections and Soldering Lugs for Use with Copper Conductors

1.04 SUBMITTALS

- A. Contractor shall employ personnel qualified by education, training and experience to fulfill requirements of this specification. To accomplish this for gradient control systems installation, as part of AC interference mitigation systems, it may be necessary for Contractor to subcontract all or part of the work required by this specification. (Contractor shall coordinate installations performed by subcontractors with pipeline construction so as to avoid delays in construction of the pipeline.) Contractor shall submit to the Project Manager approval of qualifications for all personnel and subcontractors that are to perform work required by this specification.
- B. Manufacturer's catalog cuts shall be submitted to the Project Manager in accordance with Section 01330 – "Submittal Procedures". The catalog cuts shall include the manufacturer's name and shall provide sufficient information to show that the items meet the requirements of the Contract Documents. Where more than one item or catalog number appears on a catalog cut, the proposed item shall be clearly identified.
- C. As-built drawings of the potential gradient control mats at cathodic protection test stations or other above grade apparatus shall be prepared and maintained by Contractor during construction and installation. As-built drawings shall show exact locations and dimensions of all installations covered by this specification. All items of equipment and material shall be properly identified on the As-built drawings. As-built drawings shall be submitted to the Project Manager after completion of construction.

1.05 RELATED REQUIREMENTS

- A. Section 1330 – "Submittal Procedures".
- B. Section 16062 – "Corrosion Control Test Stations".
- C. Section 16640 – "Cathodic Protection for Pipelines".

1.06 QUALITY ASSURANCE

- A. Contractor shall note other utilities and structures near the construction sites and repair any damaged utilities to the satisfaction of the owner at the Contractor's expense.
- B. All equipment, materials, fabrications, and installations are subject to inspection and testing by the Owner or its designated representative. Testing and inspection by

Owner does not relieve the Contractor of any obligation for full compliance with this Specification.

1.07 – 1.13 NOT USED

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

A. Zinc Ribbon

1. The alloy of the zinc ribbon will be ASTM B418 (latest revision), Type II, for use in soil applications. Composition of the zinc alloy will be as follows: aluminum - 0.005% maximum, cadmium – 0.003% maximum, iron – 0.0014% maximum, lead – 0.003% maximum, copper – 0.002% maximum, with the remainder to be zinc.
2. The zinc ribbon will be of the “standard” size with cross sectional dimensions of 1/2-inch diagonal width and 9/16-inch diagonal height.
3. The zinc ribbon will have a 1/8-inch diameter steel wire core to which the zinc will be permanently bonded.
4. The zinc ribbon will be coiled in 1000-foot long rolls from the manufacturer.

B. Potential Gradient Control Mats at CP Test Stations

1. Potential gradient control mats shall be installed at indicated cathodic protection test stations.
2. Potential gradient control mats shall be comprised of zinc ribbon, zinc ribbon lead wires, electrical connectors, insulation putty, tape and coating for electrical connections, thermite weld materials, and pipe coating repair materials.
3. Materials for potential gradient control mats at cathodic protection test stations shall be as follows:
 - a. Zinc ribbon shall be as specified in Paragraph 2.02.A of this specification.
 - b. Zinc ribbon lead wires shall be No. 6 AWG single conductor stranded copper wire with high molecular weight polyethylene (HMWPE) insulation. The insulation shall be black in color. Each

individual lead wire shall be continuous without splices and without damage to the insulation.

- c. Electrical connectors for connecting No. 6 AWG zinc ribbon lead wires to zinc ribbon core wires shall be Burndy YC4C8 compression crimpits, or an approved equal.
- d. Materials for insulation of connections of zinc ribbon lead wires to zinc ribbon shall be electrical insulation putty, tape and coating as specified in Paragraph 2.02.D of this specification.
- e. Exothermic welding materials and pipe coating repair materials for connecting pipe lead wires to pipe shall be as specified in Paragraph 2.02.E.

C. Potential Gradient Control Mats at Valve Sites or Other Above Grade Pipeline Apparatus

1. Potential gradient control mats shall be installed at valve sites or other exposed pipeline apparatus, subject to AC interference, per the Plans.
2. Materials for the gradient control systems at valve sites or other above grade pipeline apparatus shall follow the guidance specified in Paragraph 2.02.B of this document.

D. Insulation of Buried Electrical Connections

1. All buried electrical connections involving zinc ribbon core wires and No.6 AWG wires cables shall be provided with electrical insulation using electrical insulation putty, rubber and vinyl electrical tapes and electrical coating.
2. Electrical insulation putty shall be 3M Scotchfill®, or an approved equal.
3. Rubber electrical tape shall be 3M Scotch™ 130C, or an approved equal.
4. Vinyl electrical tape shall be 3M Scotch™ Super 88, or an approved equal.
5. Electrical coating shall be 3M Scotchkote™, or an approved equal.

E. Exothermic Weld Equipment

1. Charges and Molds: Select weld charges and mold size for the specific surface configuration in accordance with manufacturer recommendations. Use Erico Cadweld, or Continental Industries Thermoweld weld charges and molds.
2. Repair coating to be 2-part epoxy repair kit SPC SP-2888 or approved equal.

Specific coating system used shall be completely compatible with pipe and factory-applied pipe coating materials.

2.03 – 2.04 NOT USED

PART 3 EXECUTION

3.01 GENERAL / MANUFACTURER(S)

This section of the specification provides information needed by Contractor to install potential gradient control systems. Equipment and materials required for installation of the systems are as specified in Part 2 of this specification. Installation requirements and details may be also found on the specification reference drawings.

3.02 PREPARATION (NOT USED)

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Installation of Potential Gradient Control Mats at Cathodic Protection Test Stations

1. Materials to be used for potential gradient control mats at cathodic protection test stations shall be those materials specified in Paragraph 2.02.B of this specification. Cathodic protection detail drawings show installation requirements and details for potential gradient control mats at cathodic protection test stations.
2. Potential gradient control mats shall be installed for all cathodic protection test stations within transmission line parallelism as well as at HVAC and pipeline crossing locations.
3. Potential gradient control mats shall be spiral runs of zinc ribbon installed around the cathodic protection test stations with two lead wires that connect the mats directly to the pipeline. The mats can be pre-fabricated with supplied two lead wire connections. The mats shall be installed approximately 12 inches below final grade and shall extend approximately 4 feet horizontally around the test stations. Backfill directly above the mats shall be finished to final grade with a 2-inch thick layer of backfill conforming with AWWA Standards and a 4-inch thick layer of fine-to- medium gravel.
4. Prior to backfilling the pipeline at cathodic protection test stations, two lead wires shall be installed on the pipeline as close as practicable to the test stations. The lead wires shall be connected to the pipeline as specified in Paragraph 3.03.B of this specification. The lead wires shall be sufficiently long to reach from the pipeline to the connection points on the zinc ribbon with approximately 12 inches of slack in the lead wires for backfill settlement.

5. After installing the lead wires on the pipeline, the pipeline shall be backfilled to approximately 12 inches below final grade. Backfill material shall be approved backfill in accordance with AWWA Standards. The surface of this initial backfill shall be relatively smooth and level to provide a supporting bed for the zinc ribbon. The lead wires shall be protected from damage during the backfill operation and shall be maintained in a vertical position so that the loose ends of the wires are accessible after this initial backfilling operation is complete.
 6. After the initial backfilling operation is complete, zinc ribbon shall be laid down in spirals around the test stations. The spirals shall start approximately 6 inches away from the test station posts and continue in a spiral until the outside run of ribbon is no less than 4 feet horizontally from all touchable points on the test stations. Separation between any two adjacent runs of ribbon shall be approximately 6 inches. The ribbon shall be formed in a manner that will not damage the zinc or the steel wire core and so that the spiral of ribbon will lie flat on the surface of the backfill.
 7. Following placement of the spirals of zinc ribbon, the two lead wires that were installed on the pipeline shall be attached to the two ends of the zinc ribbon. Connections of lead wires to ribbon core wires shall be accomplished using the specified compression crimpits. After the connections are completed, the connections shall be insulated using electrical insulation putty, tape and coating as specified in Paragraph 3.03.C of this specification.
 8. Final backfilling of the potential gradient control mat shall be accomplished by placing a layer of backfill on top of the mat and a layer of fine-to-medium gravel on top of the sifted native soil backfill. The soil shall be firmly compacted to a thickness of approximately 2 inches prior to placing the gravel. The layer of gravel shall be approximately 4 inches thick and shall fully cover the soil backfill immediately above the zinc ribbon.
- B. Installation of Potential Gradient Control Mats at Valve Sites or Other Above Grade Pipeline Apparatus
1. The quantity of gradient control mats for sites other than cathodic protection test stations should be determined by the specific site dimensions and should be specified on the Plans.
 2. Gradient control mats shall be arranged to accommodate specific sites and should cover the entire area of no less than 4 feet away from any above grade pipeline apparatus.
- C. Wire and Cable Connections to Pipe

Wire and cable connections to pipe shall be made using the exothermic weld process and exothermic welding materials and equipment as shown on the specification reference drawing No. 34.

1. Attach test leads to the pipe by exothermic welding following the manufacturer's written instructions.
2. Clean and dry the pipe to which the wires are to be attached.
3. Remove all coating, mill scale, oxide, grease, and dirt from an area approximately 3 inches square to effect a bright metal surface.
4. Remove approximately 1 inch of insulation from each end of the wires to be exothermically welded to the pipe, exposing clean, oxide-free copper for welding.
5. Using the proper size exothermic weld mold and charge as recommended by the manufacturer, place the wire between the graphite mold and the prepared metal surface. Use a copper sleeve crimped over the wire for all No. 12 AWG wires.
6. Place the metal disk in the bottom of the mold. Pour the exothermic weld charge into the mold. Squeeze the bottom of the cartridge to spread ignition powder over the charge, in case that it is consistent with the manufacturer specification.
7. Close the mold cover and ignite the starting powder with a flint gun.
8. After the exothermic reaction, remove the thermite weld mold and gently strike the weld with a hammer to remove the weld slag. Pull on the wire to assure a secure connection. If the weld is not secure or the wire breaks, repeat the procedure.
9. If the weld is secure, coat all bare metal and weld metal with 2-part epoxy.

D. Insulation of Buried Electrical Connections

1. All buried electrical connections involving zinc ribbon core wires and No. 6 AWG wires shall be provided with electrical insulation using electrical insulation putty, electrical coating, and rubber and vinyl electrical tapes as specified in Paragraph 2.02.D of this specification.
2. After the electrical connection has been completed, surfaces of wire and cable insulation shall be trimmed to remove any irregularities or slivers protruding from the insulation. All wire and cable strand ends that are unnecessarily long or that are protruding from the connection shall be cut off. Zinc ribbon, its

core wire, and wire and cable shall be bent into a configuration that will facilitate easy application of the electrical insulation putty and the rubber and vinyl tapes.

3. After the electrical connection has been properly prepared, the electrical insulation putty shall be applied to the connection in a manner that will fill and contour any voids and irregularities around the connection, up to the zinc ribbon and up to the insulation on wire and cable. Prior to application of the insulation putty, all surfaces to which the putty is to be applied shall be clean, dry and free of oil, grease and any other debris. Manufacturer instructions shall be followed during application of the insulation putty.
4. After application of the electrical insulation putty, the connection shall be wrapped with the specified rubber tape. Prior to application of the rubber tape, all surfaces to be wrapped shall be clean, dry and free of oil, grease and any other debris. A minimum of two full layers of rubber tape shall be applied over the entire connection area and extend a minimum of 1 inch onto zinc ribbon and wire and cable insulation. Each wrap of rubber tape shall overlap previous wraps by a minimum of $\frac{1}{2}$ of the width of the rubber tape. Manufacturer instructions shall be followed during application of the rubber tape.
5. After application of the rubber tape, the connection shall be wrapped with the specified vinyl tape. Prior to application of the vinyl tape, all surfaces to be wrapped shall be clean, dry and free of oil, grease and any other debris. A minimum of two full layers of vinyl tape shall be applied over the entire area previously wrapped with rubber tape. The vinyl tape shall extend a short distance beyond the ends of the rubber tape. Each wrap of vinyl tape shall overlap previous wraps by a minimum of $\frac{1}{2}$ of the width of the vinyl tape. Manufacturer instructions shall be followed during application of the vinyl tape.
6. After application of the vinyl tape, the entire taped connection shall be coated with the specified electrical coating. Prior to application of the electrical coating, all surfaces to be coated shall be clean, dry and free of oil, grease and any other debris. The electrical coating shall be applied evenly over the taped connection and extend onto zinc ribbon and onto wire and cable insulation for a minimum of $\frac{1}{2}$ inch. Manufacturer instructions shall be followed during application of the electrical coating.

3.04 REPAIR/RESTORATION

A. Determination and Correction of Deficiencies

1. Determinations of deficiencies shall be made by the Owner or its

representative.

2. Contractor shall correct any and all deficiencies in equipment, materials and any and all deficiencies in installation to the satisfaction of the Owner at the Contractor's expense.

3.05 – 3.07 NOT USED

3.08 DEMONSTRATION / TESTING AND INSPECTIONS

A. Inspection of Equipment, Materials and Installation

1. All equipment and materials installed under this specification and all installation procedures and techniques employed by Contractor are subject to inspection and testing by the Owner or its representative.
2. The Owner reserves the right to reject any equipment or materials that do not comply with this specification and to halt installations of same if installation procedures or techniques compromise proper installation or jeopardize safety.

B. Testing of Systems Following Completion of Installation

1. Contractor shall provide qualified personnel to test operation and function of all equipment and materials installed under this specification. These personnel shall be those pre-approved by the Owner as required in Paragraph 1.04.A of this specification. Testing plans and schedules shall be provided to the Owner at least two weeks in advance of testing for approval and so that arrangements can be made for witnessing of the tests by the Owner or its representative.
2. Operation and function testing shall be performed in a manner that is standard for the type of equipment or material being tested. Full documentation of test procedures and test results shall be produced and provided to the Owner.
3. The Owner reserves the right to perform independent testing of equipment and materials.

3.09 – 3.10 NOT USED

END OF SECTION