WATER AGENCIES' STANDARDS

STANDARD SPECIFICATIONS

SECTION 13110 CATHODIC PROTECTION AND JOINT BONDING

PART 1 GENERAL

1.01 DESCRIPTION

This section includes materials, testing and installation of corrosion protection and monitoring systems for metallic pipes including insulating flange kits, test stations, copper/copper sulfate reference electrodes, sacrificial anodes, wiring, and exothermic welds.

1.02 REFERENCE STANDARDS

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	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	RPO286 -	The Electrical Isolation of Cathodically Protected Pipelines
NACE	RPO375 -	Application and Handling of Wax-Type Protective Coatings and Wrapper Systems for Underground Pipelines

1.03 RELATED WORK SPECIFIED ELSEWHERE

WAS Standard Drawings
WAS Standard Specifications 01000, 02222, 02223, 03000, 15000, 15056, 15057, and 15061.

1.04 SUBMITTALS

Submit manufacturer's catalog data on wire and cable, copper sulfate reference electrodes, test stations, conduit, exothermic weld molds and charges, pipe flange insulation kits, pipe flange internal coating, wax tape system, plastic warning tape, sacrificial anodes, and any other required materials.

1.05 MANUFACTURERS

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.

1.06 PIPE JOINT BONDING CABLES

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 insulation gaskets. Where shown on the drawings, bonding cables shall be installed in vaults.

1.07 GALVANIC ISOLATION

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 District Engineer. Where the use of nylon bushings is required, the threaded outlet shall be increased in size to accept the bushing.

1.08 WARNING/IDENTIFICATION TAPE

All cathodic protection test wires, cables and conduit shall include Warning/Identification Tape in accordance with Section 15000.

PART 2 MATERIALS

2.01 GENERAL

Items in this section shall be selected from the Approved Materials List in accordance with the Standard Drawings.

2.02 TEST STATION BOXES

Cathodic test station boxes shall be circular precast concrete boxes with ductile-iron covers selected from the Approved Materials List

2.03 PREPACKAGED COPPER SULFATE REFERENCE ELECTRODE

A. Copper sulfate reference electrodes shall be constructed with an ion trap to prevent contamination. The reference electrode shall have a design life of 15 years and a stability of +/- 5 millivolts under a 3.0 microampere load.

B. Provide reference electrodes with minimum No. 10 AWG HMW/PE (yellow) insulated wire. Each lead wire shall be long enough to extend to the corrosion monitoring test box plus 450mm (18") of slack without splices.

C. Reference electrodes shall be prepackaged in a permeable cotton cloth bag with low resistivity backfill mixture to protect against the "drying out" type of failure. The backfill mixture shall be composed of 50% Gypsum and 50% Powdered Bentonite.

2.04 PREPACKAGED MAGNESIUM ANODES

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 Standard Drawings.

A. 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.

B. Provide magnesium anodes with minimum No. 8 AWG HMW/PE (black) insulated wire. Each lead wire shall be long enough to extend to the corrosion monitoring test box plus 450mm (18") of slack without splices.

C. Magnesium anodes shall be prepackaged in a permeable cloth bag with low resistivity backfill mixture and shall be selected from the Approved Materials List.

2.05 SACRIFICIAL ANODES FOR COPPER TUBING

Prepackaged zinc sacrificial anodes shall be installed and connected to copper tubing where indicated on the Approved Plans. Anodes shall be selected from the Approved Materials List and shall be installed in accordance with the Standard Drawings.

A. Prepackaged zinc sacrificial anodes shall include a zinc-alloy ingot with galvanized steel core weighing not less than 6.8 kg (15 lbs.) and shall be packed in cloth bags filled with a mixture of gypsum and bentonite.

B. Prepackaged zinc sacrificial anodes shall include an integral anode lead connected to the galvanized steel core of the ingot consisting of No. 12 AWG stranded copper wire with (black) THW insulation. Anode lead wires shall be a minimum of 7.62 m (25') long.

2.06 TEST CABLE AND BONDING CABLE

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 box without splices.

The cable shall have a 2.8mm (7/64") thick, high molecular weight polyethylene (HMW/PE) 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. Test cable shall have at least 450mm (18") of slack in the test box. Cable size shall be in accordance with the Standard Drawings.

2.07 PIPE FLANGE INSULATING KITS

All pipe flange-insulating materials shall be of the type designated by the manufacturer as suitable for service at the operating temperatures and pressures of the pipeline.

A. Insulating gaskets shall be full-face dielectric neoprene-faced phenolic.

B. Insulating sleeves shall be full-length phenolic

C. Insulating washers shall be phenolic.

D. Steel bolts, nuts, and washers shall be in accordance with Section 15000.

2.08 ADDITIONAL SMOOTH EPOXY LINING AT INSULATED PIPE FLANGES

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.

2.09 TAPE WRAP FOR ABOVEGROUND INSULATED PIPE FLANGES

All aboveground insulated pipe flanges shall be wrapped with minimum 0.36mm (14 mil) thick general utility pipeline tape in accordance with the Approved Materials List.

2.10 WAX TAPE COATING FOR BURIED INSULATED PIPE FLANGES

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 in accordance with the Approved Materials List. Wax tape is also required where indicated on the Approved Plans.

A. 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	37.8º C - 43.3º C (100º -110º F)
Flash Point	176.7º C (350º F)
Coverage	0.41 L/M^2 (1 gal/100 sq. ft.)

B. 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	46.1º C - 48.9º C (115º - 120º F)
Thickness	1.27 - 1.78 mm (50 - 70 mils)
Tape Width	150mm (6")
Dielectric Strength	170 volts/mil

C. 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

2.11 EXOTHERMIC WELD MOLDS AND WELD CHARGES

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.

2.12 REPAIR GROUT FOR EXOTHERMIC WELDS

Repair grout shall be in accordance with cement-mortar grout described in Section 15061.

2.13 BRASS IDENTIFICATION TAGS

All wires terminating in 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.

2.14 WARNING/IDENTIFICATION TAPE

Warning/Identification tape materials shall be in accordance with Section 15000 and the Approved Materials List.

2.15 CONCRETE

Concrete shall be in accordance with Section 03000.

PART 3 EXECUTION

3.01 CORROSION MONITORING TEST STATIONS

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 Standard Drawings. A utility marker post shall be installed, in accordance with the Standard Drawings, when indicated on the Approved Plans.

3.02 EXOTHERMIC WELDS

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

A. 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.

B. 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. For cement-mortar coated pipe, a nominal 75mm x 75mm (3" x 3") area of cement mortar shall be chipped off.

C. 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 30º to 45º 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.

D. Weldment Test: After the exothermic weld has cooled, the weld shall be tested by the Contractor for strength, in the presence of the District 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.

E. Repair Grout: The area to be repaired shall be thoroughly clean and dry. Cement-mortar coating shall be repaired or replaced to original condition by hand-placing cement-mortar repair grout as directed by the District Engineer.

3.03 PIPE FLANGE INSULATING KITS

Pipe flange insulating kits shall be installed at the locations shown on the Approved Plans and in accordance with the Standard Drawings and the manufacturer's recommendations. Insulation shall also conform to the National Association of Corrosion Engineers' Recommended Practice RPO286 "Electrical Isolation of Cathodically Protected Pipelines". 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. 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. 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. 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.

3.04 ADDITIONAL SMOOTH EPOXY LINING AT INSULATED PIPE FLANGES

At all insulated pipe flanges, an additional two-part smooth epoxy lining shall be applied. The interior of the pipe and flanges shall be coated with the two-part smooth epoxy for a distance of two pipe diameters in each direction away from the insulated pipe flange.

A. 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.

B. Mixing the Coating: The two-part epoxy paint shall be mixed per the manufacturer's recommendations. The two-part epoxy shall be mixed thoroughly for at least two minutes by hand or with a mechanical mixer before being applied by brush.

C. Applying The Coating: The application of the undiluted coating shall be made by brushing until a minimum dry film thickness (DFT) of 0.51mm (20 mil) is achieved. Each subsequent coat shall be applied before the preceding coat cures, which is normally within 3-6 hours. The application of the coating shall be per the guidelines and at the rate recommended by the coating manufacturer.

3.05 WAX-TAPE COATING FOR BURIED INSULATED PIPE FLANGES

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.

A. 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.

B. 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.

C. 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.

3.06 PREPACKAGED MAGNESIUM ANODES

Prepackaged magnesium anodes shall be placed a minimum of 1.5m (5') below the pipe in the trench or an augured hole. Soaking of the anode is not required. Backfill material around the prepackaged anodes shall be as specified for the pipeline trench. Installation shall be in accordance with the Standard Drawings.

3.07 SACRIFICIAL ANODES FOR COPPER TUBING

Prepackaged zinc sacrificial anodes shall be installed in accordance with the Standard Drawings.

A. Anode Location:

1. Anodes to be attached to new copper tubing installed by trenching shall be installed horizontally, and shall be located within the paved roadway approximately 1.52m (5') to 3.05m (10') from the edge of the roadway. New copper tubing trench shall be over-excavated at anode location to a depth necessary to provide 600mm (24") minimum vertical separation between new copper tubing and anode.

2. Anodes to be attached to existing copper tubing or to new copper tubing to be installed by boring shall be installed vertically in a 1.22m (4') deep, 200mm (8") minimum diameter augured hole located adjacent to the meter box.

3. Anodes to be attached to existing copper tubing in conjunction with the replacement of existing pipelines shall be installed horizontally, and shall be located within the new water main trench below the new water main. New water main trench shall be over-excavated directly below locations where new water main is to be connected to existing copper tubing to a depth necessary to provide 600mm (24") minimum vertical separation between copper tubing and anode.

B. Anodes shall be hand-placed into over-excavated trenches or augured holes. Anodes shall be handled with care and shall not be carried, suspended or dropped by holding the attached lead wire.

C. Anode Attachment:

1. Anodes to be installed within new copper tubing trenches or within augured holes as described above and intended for the protection of service laterals shall be attached to copper tubing within meter boxes. Anode lead wire shall be securely attached to the copper tubing between anode and meter box, 600mm (24") of excess wire shall be coiled above ground within the meter box and remaining wire shall be cut. 50mm (2") of insulation shall be removed from end of anode lead wire and bare wire shall be clamped to the vertical portion of the copper tubing lying immediately below the angle meter stop. Clamp shall be entirely brass or copper, selected from the Approved Materials List. Connection point must be waterproof and shall be securely wrapped with dielectric tape selected from the Approved Materials List.

2. Anodes to be installed within new copper tubing trenches or within augured holes as described above and intended for the protection of copper tubing for air valves shall be attached to copper tubing within air valve enclosures. Anode lead wire shall be installed through concrete air valve slab within 25mm (1") PVC sleeve, and 600mm (24") of excess wire shall be coiled and placed within the sleeve. 50mm (2") of insulation shall be removed from end of anode lead wire and bare wire shall be clamped to copper tubing 75mm (3") above concrete slab. Clamp shall be entirely brass or copper, selected from the Approved Materials List. Connection point must be waterproof and shall be securely wrapped with dielectric tape selected from the Approved Materials List.

3. Anodes to be installed within new water main trenches as described above and intended for the protection of existing copper tubing shall be clamped to copper tubing at a point approximately 25mm (3") from the corporation stop. Connection point shall be backfilled along with the new water main, and no excess wire is required. Clamp shall be entirely brass or copper, selected from the Approved Materials List. Connection point must be waterproof and shall be securely wrapped with dielectric tape selected from the Approved Materials List.

D. Over-excavated trenches or augured holes in which anodes are placed shall be backfilled with select native material from which rock or other materials larger than 25mm (1") in diameter have been removed. Over-excavated trenches shall be backfilled with native materials up to the bottom of the new water main or copper tubing trench, which shall then be backfilled with select material in accordance with these Standard Specifications. Anode and native backfill shall be thoroughly wetted after installation.

3.08 COPPER SULFATE REFERENCE ELECTRODES

Reference electrodes shall be placed 300mm (12") away from the pipe at spring line. Electrodes shall be placed opposite side of the pipe from anodes. Saturate packaged electrode in 18.9 liters (5 gallons) of water prior to installation. Backfill material around the electrode shall be as specified for the pipeline trench. Installation shall be in accordance with the Standard Drawings.

3.09 TEST CABLE

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 02223. Care shall be taken when installing wire and backfilling trench to prevent damage to the installation. Damaged wire shall be replaced in entirety.

3.10 WARNING/IDENTIFICATION TAPE

Warning/Identification Tape shall be installed in accordance with Section 15000 and the Standard Drawings

3.11 BRASS IDENTIFICATION TAG

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 or Agency name, the pipeline size, the contents of the pipeline, and the direction of the connection point along the pipe, in accordance with the Standard Drawings. Copper sulfate reference electrode tags at cathodic test boxes shall be stamped "$CuSO_4$". The tags shall be securely attached to each wire with nylon fasteners prior to pipe backfilling operations.

3.12 FIELD TESTING

The Contractor shall test the cathodic protection installations in the presence of the District Engineer. Contractor shall notify District 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..

A. Pipeline Electrical Continuity Testing: Test the electrical continuity of all sections of pipe to be monitored between each pair of adjacent corrosion 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 District Engineer.

B. 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.

D. 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.

E. Sacrificial Anode Connectivity Testing: After installation of sacrificial anodes for copper tubing, the copper tubing and sacrificial anode lead wire shall be tested for connectivity to insure that the lead wire and the brass or copper clamp has been securely connected to the copper tubing. Test method shall be as directed by the District Engineer.

3.13 CATHODIC TESTING REPORT

At the completion of the testing, a report of the results will be prepared and presented to the District 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