

# Appendix A

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## Cathodic Protection Specifications

This appendix contains two standard specifications for cathodic protection. The specifications are presented in Construction Specifications Institute (CSI) MasterFormat 2004:

- Impressed Current cathodic Protection System 26 42 00
- Test Stations 26 42 01

## SUMMARY SHEET

Section name: IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM

Section number: 26 42 00

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Reviewed by: Les Nelson

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Description: SPU Design Standards and Guidelines (DSG)

Revision #	Date	Paragraph(s) revised
1	06/01/10	Insert

**WARNING:** The standards and guidelines do not relieve licensed engineers from their responsibilities as outlined by the code of ethics and rules of practice. All specifications require editing and review by the project's licensed engineer and must be tailored to the conditions and needs of the project. The guidelines provide policy, clarity, and advice on how design should be conducted by and for Seattle Public Utilities. However, it remains the responsibility of the licensed engineer to properly interpret and apply the guidelines as appropriate to meet the needs of the project. If these standards and guidelines contain any contradictions with other standard engineering practices, the licensed engineer is responsible for identifying and resolving them.

This Section covers the work necessary to furnish and install impressed current cathodic protection systems for the various locations as identified for this project.

Note: This specification will be revised in the next version (v.3) of the Design Standards and Guidelines (DSG). This should be considered a starting point for a specification for a generic impressed current cathodic protection system.

Note: All specifications are edited for project-specific requirements.

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## **PART 1 GENERAL**

### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 26 42 01, TEST STATIONS.

### **1.02 SUMMARY**

Note: This section will be completed in the next version (v.3) of the Design Standards and Guidelines (DSG).

- A. Section includes:
  - 1.
  - 2.

### **1.03 DEFINITIONS**

- A. Lead, Lead Wires, Joint Bonds, Cable: Insulated copper conductor; the same as wire.
- B. Active Column: The anode and coke breeze portion of a deep anode ground bed that discharges current.
- C. Inactive Column: The gravel fill and seal portions of a deep anode ground bed that do not discharge current.

### **1.04 SUBMITTALS**

- A. Provide catalog cuts and other information for all materials to be used. Submittals shall be made in accordance with Section 01330, SUBMITTALS.
- B. Cathodic Protection Specialist Credentials: The CONTRACTOR shall submit the credentials of the Corrosion Specialist to the ENGINEER for review prior to starting the work. The submittal shall include the following:
  - 1. Name of individual, current job title(s), and a copy of current NACE International Cathodic Protection Specialist certificate or Professional Engineer's license.
  - 2. Title of projects (minimum of 10, for experience) with dates for the past 5 years.
  - 3. Employer with name and telephone number of contact person for each project listed.
  - 4. Contracting agency with name and telephone number of contact person for each project listed.

5. Brief technical summary of work for each project listed, including pertinent details which are similar to this project.
- C. Drilling Experience Statement: Provide the following information:
1. Name of the individual(s) who will operate the drilling equipment, current job title(s), and a copy of their current drilling license.
  2. Title of all projects (for experience) with dates for the past 5 years.
  3. Drilling company employer with name and telephone number of contact person for each project listed.
  4. Contracting agency with name and telephone number of contact person for each project listed.
  5. Brief technical summary of work for each project listed, including pertinent details which are similar to this project.
- D. Wire-to-anode connection resistance values.
- E. A written description of the method to be used for lowering the cathodic protection anodes, vent pipe, and installation of coke breeze into the holes.

## **1.05 QUALITY ASSURANCE**

- A. General: The CONTRACTOR shall provide a NACE International Cathodic Protection Specialist, or a registered Professional Engineer with a minimum of 5 years of cathodic protection experience to visit the job site during installation of the impressed current cathodic protection system. The Cathodic Protection Specialist shall be responsible to the CONTRACTOR to ensure compliance with these specifications, and for observation and testing services specified herein. The Cathodic Protection Specialist shall have experience testing and monitoring the installation for at least five deep anode cathodic protection systems and cathodic protection system components of comparable scope and complexity to those required under this contract. The CONTRACTOR shall provide the services of the Cathodic Protection Specialist at the CONTRACTOR's sole expense.
- B. Cathodic Protection Specialist shall be present at the project site during installation of the cathodic protection anodes and backfill, and shall perform the resistance tests specified during backfill operations. Additional visits to the jobsite shall be made by the Cathodic Protection Specialist at intervals as required to determine compliance with these specifications and as may be necessary to resolve field problems.
- C. Driller's Experience: Driller shall have installed a minimum of three deep anode ground beds within the last 5 years. Drillers shall be licensed in accordance with WAC 173-162.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturer's will be considered in accordance with the General Conditions.

### **2.02 MATERIAL SUPPLIERS**

- A. Suppliers listed below can usually supply the types of materials specified in this Section. Alternate suppliers will be considered, subject to approval of the ENGINEER. Address given is that of the general office; contact these offices for information regarding the location of their representative nearest the project site.
  - 1. Corrosion Control Products, Gardena, CA.
  - 2. Farwest Corrosion Control, Gardena, CA.
  - 3. Mesa Products, Inc., Tulsa, OK.
  - 4. Norton Corrosion Limited, Woodinville, WA.
  - 5. Corrpro Companies, Inc. Kent, WA

### **2.03 IMPRESSED CURRENT ANODES FOR DEEP WELLS**

- A. Type: Tubular, center-tap connection, high-silicon chromium cast iron centrifugally cast for high density, with the following dimensions and chemical composition:
  - 1. Dimensions:
    - a. Length: 84 inches minimum.
    - b. Outside Diameter: 2-21/32 inch minimum.
    - c. Wall Thickness: 13/32 inch minimum.
    - d. Weight: 69 pounds minimum.
  - 2. Composition:
    - a. Silicon: 14.20 to 14.75 percent.
    - b. Manganese: 1.50 percent maximum.
    - c. Carbon: 0.70 to 1.10 percent.
    - d. Chromium: 3.25 to 5.99 percent.
    - e. Copper: 0.50 percent maximum.

- f. Molybdenum: 0.20 percent maximum.
  - g. Iron: Remainder.
- B. Compliance Statement: Furnish a compliance statement guaranteeing that the anodes supplied meet all the requirements of this specification.
- C. Anode Tests at the Fabrication Facility: The anode supplier shall conduct, and submit to the ENGINEER, resistance tests for each anode lead wire connection to assure the finished connection does not exceed the specified resistance value. All wire-to-anode connections that exceed the specified resistance value shall be replaced by the anode supplier. Wire-to-anode resistance records shall include the following:
- 1. Anode numbering system to identify the anode tested.
  - 2. Anode lead length.
  - 3. Each anode lead length resistance, measured, before connection to anode.
  - 4. Resistance value of anode-to-wire connection as indicated by the test.
  - 5. Test equipment used.
  - 6. Test methods.
- D. Supplemental Anode: The CONTRACTOR shall include one additional anode with a lead wire length equal to the longest anode lead wire length required. The CONTRACTOR shall allow the ENGINEER to select and test any anode for connection resistance measurements and total destructive testing. The anodes shall be available for selection at least 10 working days before the anodes are installed. Failure of this anode to pass the resistance test or tensile test on the wire-to-anode connection will be cause to reject the entire anode shipment.
- E. Acceptable Anodes: Anotec "Centertec" Type 2684, manufactured by Anotec, Industries Ltd., or approved equal.
- F. Anode Wire: Supply each anode with No. 8 AWG insulated, stranded copper wire of sufficient length to extend splice-free from the anode connection to the anode junction box terminals plus 15 feet. Anode wires shall be insulated as specified under WIRE, this section.
- G. Cable Guides: Provide all anodes with a cable guide where the anode wire enters the anode tube to prevent damage to the wire insulation during handling and installation.
- H. Wire-to-Anode Connection: As shown or method approved by the ENGINEER, with a maximum resistance of 0.004 ohm. The anode connection shall be stronger than the wire. All wire-to-anode connections shall be assembled by the same supplier.
- I. Wire Labels: Label the end of each anode wire with the anode number and total wire length, stamped onto brass tags. The anodes shall be numbered sequentially from the bottom to the top. Bottom anode shall be labeled No. 1.

## **2.04 ANODE CENTRALIZERS**

- A. Mild steel assemblies that can be securely attached to the anodes to center them in the drilled hole. Centralizers shall not block the hole or impair installation of the anode, anode wire, or coke breeze. Centralizers shall be manufactured by Farwest Corrosion Control, Gardena, CA., or approved equal.

## **2.05 COKE BREEZE (FOR DEEP ANODE GROUND BEDS)**

- A. Type: Lubricated, low resistance, calcined petroleum coke, suitable for pumping, with the following composition:
  - 1. Volatile Matter: 0.25 percent maximum.
  - 2. Ash: 0.5 percent maximum.
  - 3. Sulfur: 1.6 percent maximum.
  - 4. Fixed Carbon: 99 percent minimum.
  - 5. Particle Size: 100 percent passing 16 mesh and 98 percent retained by 200 mesh.
  - 6. Bulk Density: 74 pounds per cubic foot minimum.
  - 7. Maximum Resistivity: 0.10 ohm-cm at 150 psi.
- B. Acceptable Coke Breeze: Loresco Type SC3, or approved equal.

## **2.06 SURFACE VENT PIPE**

- A. Fabricated steel pipe, galvanized, 1-1/4-inch diameter. Finish paint after installation to match guard post assembly.

## **2.07 DOWNHOLE VENT PIPE**

- A. Downhole vent shall be constructed of perforated, 1-1/4-inch diameter pipe as shown on the Drawings.
- B. Acceptable vent pipe configurations are Loresco All-Vent, manufactured by Cathodic Engineering Equipment Company, Inc., Hattiesburg, MS; or approved equal.
- C. Couplings and fittings for the vent pipes shall be Schedule 80, high-impact, rigid PVC. Fasten vent couplings and fittings with solvent-welded joints or ENGINEER-approved alternate in accordance with the manufacturer's written instructions.
- D. The bottom of the vent pipe shall be sealed with a plastic end cap or plug.

## **2.08 CASING**

- A. Well casing, if used, shall be standard weight steel in new condition. Starter (surface) steel casing need not be new, but must be in good condition. Nominal wall thickness

for steel casing shall be 0.25 inch thick. Plastic starter casing shall meet or exceed ASTM Standard F-480. All casing shall be in good condition, durable, and watertight. Casing material shall be nontoxic and resistant to water and soil corrosiveness. Casing shall meet local well drilling standards and state and local codes for well drilling and be able to withstand installation, grouting, and operating stresses. Plastic casing shall not be used in the active column (anodes) of the ground bed.

## 2.09 GROUND BED SEALING MATERIALS

- A. Ground bed sealing materials shall be in accordance with state and local regulations.
- B. Cement Grout: Composed of two parts by weight sand to one part cement and 5 to 7 gallons of water per sack of cement. Gradation of the sand shall fall within the following limits:

Sieve	Percentage Passing
3/8-in.	100
No. 4	95 to 100
No. 16	45 to 80
No. 50	10 to 30
No. 100	2 to 10

- C. Bentonite Grout: Specifically designed for the purpose of constructing or decommissioning wells, such as Loresco Perma Plug available from Cathodic Protection Equipment Co., Inc., Hattiesburg, MS; or approved equal.
- D. Puddling Clay: Stable, fine-grained (0.5 mm to 1 mm), impervious material and at least 50 percent bentonite, by volume, which is capable of providing a permanent water tight seal throughout the required sealing depth.

## 2.10 DEEP ANODE WELL CAP

- A. Two-piece, cast iron well seal with a rubber packer to form a watertight seal. Seals shall allow vent pipe penetrations with the rubber packing providing a watertight seal of the annular space. Acceptable seals are available from Campbell Manufacturing, Bechtelsville, PA; Berkeley Pump Company, Berkeley, CA; or approved equal.

## 2.11 ANODE TERMINAL BOARD

- A. Terminal Board: Include inside rectifier on phenolic panel board as shown on drawings.
- B. Panels: Panels for mounting terminal studs shall be 1/4-inch thick phenolic. A clear 1/4-inch thick clear acrylic insulating panel shall be mounted 1/4 inch above the terminal studs and cover the phenolic terminal panel. The insulating panel shall be provided with 1/4-inch diameter holes over each terminal stud or shunt measuring surface to allow contact of voltmeter test probes. The insulating panel shall be fastened above the terminal panel on 1/4-20- by 1.75-inch nickel-plated brass studs. Studs shall be locked to terminal board to prevent loosening when removing wire connections.

- C. Terminals and Connectors: Provide copper bus bar(s), terminal studs, connectors, and all necessary fasteners to connect the anode and rectifier wires.
  - 1. Copper Bus Bars: 1/4-inch and 3/4-inch, length as required.
  - 2. Terminal Studs, Washers, and Nuts: 1/4-20 nickel-plated brass.
  - 3. Connectors: Offset pressure tongue with hex head, solderless lugs, sized for the wire to be connected. Burndy series KPA, Panduit series CB, or approved equal.
- D. Shunts: Agra Type JB, 0.01 ohm with 8 ampere capacity. Provide with holes for 1/4-inch diameter fasteners.
- E. Schematic: Supply a plastic laminated schematic drawing that identifies the wire terminations at the terminal studs. The schematic plate shall be securely fastened to the inside face of the rectifier access door.

## **2.12 IMPRESSED CURRENT ANODES FOR DISTRIBUTED GROUNDED INSTALLATION**

- A. Graphite Anodes
  - 1. Graphite anodes shall be 99% pure carbon and shall be paraffin wax impregnated. They shall be 80 inches long by 4 inches in diameter and shall weigh 62 pounds bare, minimum.
  - 2. Acceptable Distributors
    - a. Farwest Corrosion Control
    - b. Mesa Products, Inc.
    - c. Corrpro Companies, Inc.
- B. Anode Wires
  - 1. Each anode lead wire shall be a continuous AWG #8, 7 strand copperconductor with black HMW-PE type insulation.
  - 2. Each anode lead wire shall be of sufficient length to reach from the anode assembly to the header cable splice. Additional splices will not be allowed in the anode lead wire.
- C. Wire-to-Anode Connection
  - 1. Each anode shall have a center-connect lead wire. The maximum electrical resistance of the connection shall not exceed 0.004 ohms. The minimum pull-out strength of the anode lead wire shall exceed that of the breaking strength of the anode lead wire.
- D. Anode Cap

1. The anode cap material shall be water resistant and form a tightly bonded seal to the anode material and lead wire.

E. Coke Breeze Backfill (For Distributed Ground Bed Installation)

1. Calcined Petroleum Coke: Coke breeze backfill shall be low resistance, calcined petroleum coke, and shall have the following properties:
  - a. Carbon (L.O.I. netgid): 99.0%
  - b. Moisture: 0.10%
  - c. Ash: 0.35%
  - d. VCM: 0.30%
  - e. Sulfur: 3.75%
  - f. Bulk Density (lbs/cu. ft): 46-50
  - g. Resistivity @ 150 PSI: (ohm-cm) 0.005
2. Acceptable Products: Asbury Graphite, Asbury No.218LI or equal.

## 2.13 RECTIFIER

- A. Rectifier Manufacturers: The rectifiers shall be the product of a company currently engaged in the manufacture of cathodic protection equipment and shall conform in all respects to NEMA Standards. Acceptable rectifier manufacturers are:
  1. Universal Rectifiers, Inc.  
1613 Cottonwood Road  
Rosenberg, TX 77471
- B. General: Air cooled, manually controlled meeting NEMA standards. The rectifier shall be designed to operate continuously at an ambient temperature of 45 degrees C and shall be capable of 110 percent of rated input without damage to the rectifier components.
- C. AC Input:
  1. Alternates 1, 3, and 4: 115/230 volts, single-phase, 60 Hz. Provide a suitably sized magnetic type circuit breaker mounted on the rectifier panel.
  2. Alternate 2: 480 volts, three-phase, 60 Hz. Provide a suitably sized magnetic circuit breaker mounted on rectifier panel.
- D. Transformer: Two-winding, insulating type, meeting the requirements of NEMA, UL, and CSA. Provide with fine and coarse secondary taps with rectifier output controlled by a minimum of 20 evenly divided steps of adjustment. Coarse and fine taps shall be arranged in consecutive order. All transformer insulation shall be rated for a minimum

- temperature of 130 degrees C with actual hottest spot temperature at rated conditions not to exceed 100 degrees C.
- E. Rectifying Elements: Full wave bridge, silicon diode stack with efficiency filter, with metal oxide thyristors and current limiting devices for overvoltage and overcurrent protection of the stack.
  - F. Output rating: 50 volts, 34 amperes.
  - G. Lightning Protection: Provide lightning protection devices for AC input and DC output. AC lightning protection shall be rated to absorb up to 1,000 joules of energy per phase. The DC protection shall be rated to absorb 500 joules. Furnish one spare set of lightning protectors for each rectifier.
  - H. Meters: Separate DC voltage and current meters, D'Arsenal jeweled movement type, accurate to within 2 percent of actual voltage and current output. Meters shall be field tested for accuracy; inaccurate meters shall be replaced.
  - I. Shunt: Holloway type shunt mounted in series with the ammeter, with voltage and current clearly identified on shunt body.
  - J. NEMA 3R Enclosure: 14-gauge stainless steel 36" width x 24" deep x 42" high. Provide with hinged doors on both sides to allow access, stainless steel latches, and hasp for locking. Enclosure shall be sealed to protect the interior components from weather, vandalism, and nest building insects, and shall provide adequate ventilation. Install per City of Seattle Std., Plan 500 and drawings.
  - K. Panelboard: Non-metallic, suitable for mounting meters, shunt, circuit breaker, fuses and output terminals. Panelboard shall be located as shown on drawings and to allow access for testing and adjustment. Clearly engrave or identify with a permanent marking system the polarity of output terminals, fine and course transformer tap settings, meters, and fuses. All anode terminations shall occur on this panel board opposite side from the rectifier location, as shown on dwgs.
  - L. Convenience Outlet: Provide a 115V AC Ground Fault Interrupting (GFI) convenience outlet installed on the rectifier panel.
  - M. Current Interrupter: Provide a solid state timing device to interrupt secondary current. Interrupter shall be capable of continuous operation, and shall consist of a 1-minute adjustable recycling mechanical timer or electronic timer, a "Test-Normal" toggle switch, and a relay or connector to interrupt the main current.
  - N. Mounting Hardware: Tap studs, tap bars, nuts, washers and other mounting hardware shall be suitably sized brass or tin-plated copper.
  - O. Nameplate: Engraved metal plate mounted on the interior side of the front door listing the manufacturer name, model number, serial number, year manufactured, and AC and DC input and output electrical ratings.
  - P. Rectifier Enclosure Nameplate:

1. Attach a permanent nameplate to the exterior of each rectifier enclosure. Locate the nameplate 1 foot below the top and centered on the door providing access to the front of the rectifier. Nameplate shall be engraved into a 2-inch by 8-inch 18-gauge stainless steel plate. Lettering shall be 0.375 inch high and filled with blue paint. Provide the following words on the nameplate, in two lines:

SEATTLE PUBLIC UTILITIES  
CATHODIC PROTECTION

2. The completed nameplate shall be coated with a clear polyurethane enamel with exterior catalyst and attached to the rectifier enclosure door with a minimum of six stainless steel drive rivets.
- Q. Operation and Maintenance Manuals: Provide six operation and maintenance manuals that include an electrical schematic of the rectifier, parts list with part replacement number, and troubleshooting procedures.
- R. Acceptable Rectifiers:
1. Alternates 1, 3, and 4: Universal Model ASAS-50-34-ACIRQ (Current Interrupter), Universal Rectifiers, Rosenberg, TX, or approved equal.
  2. Alternate 2: Universal Model ASAS-50-34-CCIRQ (Current Interrupter).

## **2.14 POWER SERVICE**

- A. Pedestal Rating: 100 ampere, single service pedestal enclosure with a combination meter base and two pole circuit breaker rated at 30 amperes. Provide pedestal with safety socket with factory installed test/bypass facilities.
- B. Pedestal Case: 12-gauge steel, minimum, with lockable circuit breaker cover.
- C. Special Coating: Pedestal case shall be provided with a polyamide converted epoxy coating, applied in two coats to a dry film thickness of 8 to 10 mils. Pedestals provided with a coating that does not meet or exceed this coating shall be sanded to bare metal and coated by the CONTRACTOR with the specified coating.

## **2.15 MARKING TAPE**

- A. Marking tape for buried cathodic protection system conductors shall be red, 3 inches wide, and include the words "Caution Electric Lines Buried Below."

## **2.16 GROUND ROD AND ENCLOSURE**

- A. Copper-clad steel, 5/8-inch diameter by 10 feet long. The ground rod enclosure shall conform to Standard Plan 550.1.

## **2.17 GROUND WIRE AND CLAMP**

- A. No. 6 AWG solid copper wire with a high copper content alloy or bronze bolt-on ground rod clamp or Cadweld Type GR or GT, or equal.

## 2.18 CONDUIT, LOCKNUTS, AND STRAPS

- A. PVC Conduit and Fittings: Schedule 40, UL listed for direct burial. Conduit and fittings shall meet the requirements of NEMA TC and TC3, Federal Specification W-C-1094, UL, and NEC.
- B. Locknuts, Two-Hole Straps, and Miscellaneous Hardware: Hot-dipped galvanized steel.
- C. Conduit Bushings: Threaded plastic or plastic-throated galvanized steel fittings.

## 2.19 CONCRETE

- A. Reinforcing Steel: ASTM A615, Grade 60 deformed bars.
- B. Welded Wire Fabric: ASTM A497.
- C. Formwork: Plywood.
- D. Mix: ASTM C94, Option A.
  - 1. Cement: ASTM C150, Type II, with maximum alkyl content of 0.606 percent.
  - 2. Coarse Aggregate Size: 3/4 inch.
  - 3. Design for Minimum Compressive Strength at 28 Days: 2,500 psi.

## 2.20 GUARD POSTS

- A. Schedule 40 galvanized steel pipe, with 4-inch diameter.

## 2.21 RECTIFIER PAD GROUNDING CONDUCTOR

- A. The rectifier grounding conductor shall consist of No. 4 AWG stranded, bare copper wire.

## 2.22 WIRE

- A. Rectifier to Pipeline and Anode Junction Box: Single conductor, No. 4 AWG stranded copper with 600-volt High Molecular Weight Polyethylene (HMWPE) insulation. HMWPE insulation shall be 7/64-inch thick.
- B. Impressed Current Anode Leads: Single-conductor, No. 8 AWG stranded copper with a 20-mil thick Halar primary insulation and a 65-mil HMWPE outer jacket. Acceptable anode wire is Rome Halar/HMW Polyethylene Cathodic Protection Cable, as manufactured by Rome Cable, or approved equal.
- C. AC Conductors: AC conductors from the power transformer to the meter pedestal shall be sized and insulated in accordance with code and Puget Sound Energy requirements. AC conductors from the disconnect switch to the rectifier shall be No. 10 AWG solid copper wire with THHN or THWN insulation.

## **2.23 THERMITE WELD MATERIALS**

- A. General: Thermite weld materials shall consist of wire sleeves, welders, and weld cartridges according to the weld manufacturer's recommendations for each wire size and pipe or fitting size and material. All welding materials and equipment shall be the product of a single manufacturer. Interchanging materials of different manufacturers will not be acceptable.
- B. Molds: Graphite. Ceramic "One-Shot" molds will not be acceptable.
- C. Cartridges: Cast iron thermite weld cartridges shall be used for all cast and ductile iron pipe and fittings. Maximum cartridge size shall be 25 grams for steel and 32 grams for cast and ductile iron materials, respectively.
- D. Acceptable Suppliers: Erico Products Inc. (Cadweld), Cleveland, OH; Continental Industries, Inc. (Thermo-weld), Tulsa, OK; or approved equal.

## **2.24 PIPE AND FITTING COATING REPAIR MATERIAL**

- A. Epoxy Coating Repair Material: Repair coating at thermite weld connections 100 percent solids epoxy that cures in submerged or buried conditions; Raven Linings Aquatapoxy A-7, as manufactured by Raven Linings, Tulsa, OK, or approved equal.
- B. Cement Mortar Repair Coating Material: Cement mortar in accordance with AWWA C205.

## **2.25 WIRE CONNECTORS**

- A. One-piece, tin-plated crimp-on lug connector as manufactured by Burndy Co., Thomas and Betts, or approved equal.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. The installation of the facilities herein specified and described shall conform to the latest applicable rules and as set forth herein.

### **3.02 DEEP ANODE GROUND BED INSTALLATION**

- A. General:
  - 1. All drilling operations and reporting requirements shall conform to, as a minimum, the Washington Water Well Construction Standards WAC 173-160 and WAC 173-162.
  - 2. Drilling, lowering of anodes, coke breeze placement, and backfilling shall be done in one continuous operation, and shall be observed by the CONTRACTOR's Cathodic Protection Specialist.

3. Drilling and waste disposal shall be done in accordance with the methods and procedures of the best recognized practices and shall comply with the rules and regulations of the State and County, or other governing bodies having jurisdiction. Hole shall be sealed as specified herein or as required by local well drilling regulations. The most stringent regulations shall apply.
4. The CONTRACTOR shall take all necessary precautions to avoid entrance of foreign matter into the hole, movement of soil strata, or collapsing of the hole during the progress of the work. Should movement of soil strata or collapse of the drilled hole interfere with proper completion of the ground bed, the CONTRACTOR shall recover the wires and anode strings, and ream or redrill the hole, at his sole expense. Anodes shall be replaced if necessary.
5. At all times during progress of the work, the CONTRACTOR shall protect the well in such a manner as to effectively prevent tampering or entrance of foreign matter.

B. Drilling:

1. Determine the actual location of the ground bed hole in the field with the ENGINEER before drilling begins.
2. The hole shall be constructed and casing set round, straight, and plumb.
3. Surface casing shall be set prior to completion of the first 50 feet of the hole. Casing, other than the surface casing, shall not be installed or left in the hole unless in the driller's estimation it is necessary for successful completion of the hole.
4. If steel casing is installed in the active column, it shall be cut below the surface and the top portion jacked to provide a minimum of 25 feet separation between the upper casing section and the top of the active column. Cutting and jacking operations may be completed before or after installation of the anode assembly at the CONTRACTOR's option. Plastic casing may be installed in the inactive column, at the CONTRACTOR's option, but shall not extend into the active column.
5. The hole shall be overdrilled as required to compensate for sloughing or heaving during anode installation.

- C. Test Equipment: Before construction of the deep anode ground bed begins, the CONTRACTOR shall obtain the following equipment for ground bed logging and anode resistance measurements: A Nilsson Model 400 4-pin Soil Resistance Meter, as manufactured by Nilsson Electrical Laboratory, New York, NY.

D. Electrical Logging:

1. Flush the hole and electrically log the hole in the presence of the ENGINEER to determine the downhole characteristics for optimum anode elevations.
2. Acceptable Method of Electrical Logging: Measure the resistance to earth as a section of pipe is lowered down the hole. Test with suitable meters, a short section

of weighted metal pipe connected to a low resistance metallic ground, a suitably sized wire with sufficient length to reach the bottom of the hole. Provide a wire length measuring device or footage identifications to allow determination of the test pipe depth.

3. Record the resistance reading and depth from the surface continuously or at 5-foot increments for the entire hole depth.
4. Based on the results of electrical log data and the driller's log of soil formations, the ENGINEER may modify spacing and drilled depth.
5. Submit the results of the electrical log data, in writing, to the ENGINEER.

E. Lowering of Anodes:

1. Each anode wire will be inspected along its entire length by the ENGINEER prior to placement in the anode well. The terminal end of the wires shall be identified with weather-proof 3M marking tape, or by other approved method, before lowering the anodes into the hole.
2. Lowering of the anodes shall be done after the drilling is completed. Actual lowering of the anodes and backfilling with coke breeze shall be observed by the ENGINEER.
3. Installation of the anodes and coke breeze shall be performed on the same day as the completion of the drilling and electrical logging.
4. Attach anode centralizers to each of the anodes prior to lowering.
  - a. If steel casing is used and extends into the active column, the anode centralizers shall be electrically isolated from the casing by a method approved by the ENGINEER.
  - b. Anode centralizers shall have no sharp edges that can damage wire insulation. Tape or otherwise cover sharp edges of centralizers, as approved by the ENGINEER.
5. Install anodes and vent pipe in the drilled hole using methods previously approved by the ENGINEER. No deep anode cathodic protection components shall be installed prior to approval of the installation method by the ENGINEER.
6. Vent pipe couplings shall be attached to the vent pipe using a method approved by the ENGINEER. The CONTRACTOR shall maintain the structural integrity of the vent pipe when lowering the deep well anodes.
7. Any damage to anodes or cut, gouged, or scraped wire insulation will not be acceptable. No splices to anode wires will be allowed.
8. If the hole is drilled with mud, it shall be flushed with clean water in a continuous process before or after the anodes are lowered, at the CONTRACTOR's option, until the return fluid is sufficiently clear to allow proper installation and settlement

of the coke breeze. The ENGINEER shall inspect the return fluid before the coke breeze installation will be permitted to begin.

F. Backfilling of Anode Hole:

1. The hole shall remain full of water during installation of the coke breeze.
2. Prepare a coke breeze slurry with water in accordance with the manufacturer's written recommendations. The coke breeze slurry shall be pumped into the hole at high pressure through an additional plastic pipe supplied by the CONTRACTOR. Pump the coke breeze in an even and continuous manner from the bottom of the hole to the top elevation as the plastic pipe is slowly withdrawn.
3. CONTRACTOR shall collect water that is displaced from the ground bed hole during coke breeze installation. Dispose of water in accordance with local, state, and federal regulations.
4. The CONTRACTOR's Cathodic Protection Specialist shall conduct resistance measurements between an appropriate grounded structure or the pipeline and each anode lead as the coke breeze is installed. The individual anode resistance measurements shall start at the bottom anode. When the resistance measurement indicates that the coke breeze level has covered the bottom anode, the test leads shall be connected to the next higher anode wire and the resistance measurement monitored as the coke breeze is installed. The resistance measurements shall be used by the CONTRACTOR to monitor the coke breeze level in the drilled hole and detect possible coke breeze bridging problems during installation.
5. In the event that voids or bridging occurs during introduction of the coke breeze, the operation shall cease until the voids have been eliminated. The CONTRACTOR shall correct the deficiency to the satisfaction of the ENGINEER.
6. The CONTRACTOR shall allow the coke breeze to settle for 12 hours before installation of the permanent well seal. After 12 hours, the depth of the coke breeze shall be measured and additional coke breeze added to plan elevation, as required.
7. Install washed gravel to the depth shown or as required by code.

G. Placement of Seal:

1. Place seal by pumping or forcing material from top of gravel backfill to within 18 inches of finished grade. Place seal in such a manner that ensures entire filling of the space in one continuous operation.
2. Install sealing material in the annular space between the casing and the soil.

H. Anode Wire Termination: The CONTRACTOR shall cut a smooth hole in the side of the casing for routing wires to the anode junction box. Install a rubber grommet or pipe with plastic bushings on both ends in the hole to prevent damage to the wire insulation by the casing.

- I. Ground bed and Vent Pipe Termination: Place vent pipe through well cap, and connect the steel portion of the vent pipe to the plastic vent pipe with the appropriate threaded coupling, 6 inches minimum below grade. Place well cap in casing and torque bolts in accordance with the manufacturer's recommendations.
- J. Secure the anode vent pipe to a Unistrut support located at the back of the rectifier.

### **3.03 DISTRIBUTED ANODE GROUND BED INSTALLATION**

#### **A. General**

- 1. The existing header cables are connected to existing graphite anodes per CH2M plan S7855.6 dated 10/31/73. A total of 49 anodes were installed in the space between Cedar River Pipelines (CRPL's) No. 1,2 and 1,3 using 4 separate header cables. The intent of this contract is to make use of the existing header cables for connecting the new anodes to the existing rectifier.

#### **B. Anode to header cable connection**

- 1. Connection of new anodes to existing (or replaced) header cable shall be made by removing the existing header cable insulation for a length necessary to make the electrical connection without damaging existing wire strands.
- 2. Connection shall be made by encapsulating with an epoxy splice kit as manufactured by 3M or equal. The remaining cable insulation that will be covered by the epoxy splice kit shall be roughened with 100 grit sandpaper to provide additional surface area and roughness for bonding to the epoxy.
- 3. Lowering of anodes into drilled holes shall be per industry standard and comply with anode manufacturer recommended handling procedures. Addition of coke breeze shall be accomplished while maintaining centering of the anode in the drilled hole.
- 4. The assigned CP specialist shall submit an installation plan for approval by SPU describing the following:
  - a. Method of lowering anodes to avoid stress on lead wire.
  - b. Method of installation of coke breeze and centering of anode during installation in drilled hole.
  - c. Include material submittals for all other materials proposed for this work.

### **3.04 RECTIFIER GROUNDING CONDUCTOR**

- A. Rectifier grounding conductor shall be placed before installation of the concrete slab.
- B. Connect the grounding conductor to the rectifier case using the grounding lug provided by the rectifier manufacturer.

### **3.05 TRENCHING AND BACKFILL**

- A. Complete excavations and trenching regardless of the type, nature, or condition of materials encountered, as required to accomplish specified construction.
- B. Take care to avoid damage to existing structures and utilities during excavating and trenching process. Cathodic protection excavations and cable trenches shall be in the general location and route as shown. CONTRACTOR may modify location as approved by the ENGINEER as required to minimize possible damage to existing structures. Trench shall be of uniform depth and width, level, smooth, and free of sharp objects. Hand trenching may be required in some areas to avoid damage to existing structures.
- C. Sheet and brace excavations and trenches as necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, property, workers, and the public.
- D. Place 3 inches minimum bedding below pipe or conduit, and pipe zone material to 6 inches above pipe or conduit. Thoroughly tamp each lift with handheld tamping bar or other approved mechanical means so no subsequent settlement will occur. Bedding and pipe zone materials shall meet the following requirements:
  - 1. Sand, clean or clean to silty, less than 12 percent passing No. 200 sieve.
  - 2. Individual Particles: Free of sharp edges.
  - 3. Maximum Size Particle: Pass a No. 4 sieve.
  - 4. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.
- E. Backfill trench above the pipe zone with excavated backfill materials, tamp, and compact so that no subsequent settlement will occur. Do not use backfill material of frozen or consolidated debris. Leave the trench with the excess backfill material neatly mounded not more than 4 inches above the existing ground level for the entire width of the trench.

### **3.06 SLAB AND GUARD POST ASSEMBLY**

- A. Fabricate assemblies, setting posts plumb and straight with concrete footing. Fill posts with concrete and top with rounded grout plug.
- B. Grind all rough spots or sharp edges or steel posts. Solvent clean (SSPC SP-1) and coat with 1 coat of rust inhibitive primer and two coats of yellow alkyd enamel paint. Total coating system shall be 6 mils dry film thickness, minimum.

### **3.07 CONDUITS**

- A. Unless otherwise noted on the Drawings, all conduits shall be PVC coated rigid galvanized steel.

- B. Conduit shall be sized in accordance with the NEC and shall be of such size and so installed that conductors may be drawn in without injury or excessive strain.
- C. Conduits entering cabinets, junction boxes, or terminal boxes shall be secured with conduit hubs.
- D. Install insulated bushings and insulated throat connectors on the ends of all rigid metallic conduit.
- E. Use watertight couplings and connections. Install and equip boxes and fittings to prevent water from entering the conduit or box. Seal all unused openings.

### **3.08 ANODE TERMINAL BOX INSTALLATION**

- A. Connect the rectifier positive lead and anode wires to the junction box terminals with the shunts, bus bars, and appropriate fasteners.
- B. Label wires in the terminal box with heat-shrink tags identifying the anode number and rectifier lead. Connect numbered anodes in consecutive order to anode terminals starting with number 1 at the top left hand side. Maintain sufficient slack to keep the wire from being unduly stressed, damaged, or broken during backfill.

### **3.09 RECTIFIER INSTALLATION**

- A. Provide all conductors and electrical hardware necessary for the rectifier installation.
- B. Rectifier wire from the rectifier negative terminal shall be installed to the pipeline. Rectifier wire from the rectifier positive terminal shall be installed to the anode terminal box.
- C. Provide the ENGINEER with 10 working days prior notice to the completion of the rectifier, ground bed, and AC power service installation to allow scheduling of the required energizing and testing.

### **3.10 AC POWER SERVICE**

- A. Provide alternating current power to the rectifier disconnect switch in accordance with Puget Sound Energy requirements. Power service installation shall meet or exceed local and NEC code requirements. At the Tukwila site provide power to the rectifier breaker/disconnect from the existing handhole as shown on sheet 6 of the Drawings.
- B. Coordinate installation of the electrical power service with Puget Sound Energy. The CONTRACTOR shall pay for all electrical utility connection fees and inspection services that may be required. At Beacon/119<sup>th</sup> provide new AC service from existing power pole through 2" conduit to the new meter and AC disconnect on the new rectifier. Existing rectifier to receive power through a 1" conduit from the new rectifier crossing Beacon Ave. Coordinate installation of the electrical service with Seattle City Light.
- C. The service disconnect shall be grounded with a minimum of two ground rods placed at least 8 feet apart near the pad, per Puget Sound Energy requirements and NEC.

The top of the ground rods shall be covered with a ground rod handhole in accordance with City of Seattle Standard Plan No. 550b.

- D. Electrical service grounding shall not be connected to the pipeline.

### **3.11 CONDUCTOR INSTALLATION**

- A. Conductors buried in the ground shall be laid without kinks. The bottom of the finished trench shall be free from stones, roots, or other materials which might damage conductor insulation or conduit. All cables from the top of the pipe or anode hole to enclosures shall be installed in conduit.
- B. No wire bend shall have a radius of less than 8 times the diameter of the wire. Copper or bronze offset pressure tongue with hex head solderless lugs shall be used to make all cable connections to terminal studs.
- C. No wire shall be drawn into conduit until conduit system is complete. Lubricant shall be approved by wire manufacturer.
- D. Arrange conductors neatly in rectifier and junction or terminal box. Cut to proper length, remove surplus wire, and attach terminal or connect to appropriate junction box or rectifier terminal.
- E. Seal all below ground conduit to prevent intrusion of foreign material after wire is in place.
- F. Direct buried rectifier shall be 36 inches deep, minimum, below finished grade. All wires shall be free of splices, except those approved by the ENGINEER.
- G. Bury warning tape approximately 12 inches above all underground rectifier conductors and conduits. Align parallel to and within two inches of the centerline of the conduit or conductor run.

### **3.12 WIRE CONNECTIONS**

- A. The electrical connection of copper wire to steel, ductile and cast iron surfaces shall be by the thermite weld method. Observe proper safety precautions, welding procedures, thermite weld material selection, and surface preparation as recommended by the welder manufacturer. Assure that the pipe or fitting wall thickness is of sufficient thickness that the thermite weld process will not damage the integrity of the pipe or fitting wall or protective lining.
- B. Before the connection is made, the surface shall be cleaned to bare metal by making a 2-inch by 2-inch window in the coating, and then filing or grinding the surface to produce a bright metal finish. Use grinding wheels that do not leave residual material on metal surface that could affect thermite weld, as approved by the thermite weld manufacturer. The prepared metal surface shall be dry.
- C. Wire sleeves shall be installed on the ends of the wires before welding to the metal surface. Thermite welding shall be performed in strict accordance with the manufacturer's written instructions. After the weld connection has cooled, remove slag

and physically test wire connection by tapping with a hammer; remove and replace any defective connections.

- D. For thermite weld connections to concrete cylinder pipe, clean surfaces in accordance with SSPC SP1 and apply epoxy repair coating. After the epoxy coating has dried sufficiently, cover the connection with 3/4 inch to 1 inch of cement mortar. Repair coatings shall be placed over all exposed steel where cement mortar was removed. For thermite weld connections to manholes or other pipe surfaces not coated with cement, extend the repair coatings a minimum of 2 inches from all edges of the completed thermite weld. As an alternative to the methods described above for sealing of thermite welds, see Section 16641, 2.08 THERMITE WELD CAPS and 2.09 PIPE AND FITTING COATING REPAIR MATERIAL.

### **3.13 ENERGIZING AND TESTING**

- A. Electrical power circuits shall be energized only after the installation is tested for proper wiring connections by the CONTRACTOR.
  - 1. As a minimum, these tests shall consist of the following:
    - a. Test for electrical continuity of each circuit.
    - b. Test for grounds in each circuit, which consists of the physical examination of the installation to ensure that all required ground jumpers, devices, and appurtenances do exist and are mechanically firm, meeting the requirements of Article 250 of the NEC.
  - 2. All systems shall be run under operating conditions for a minimum of 1 month to ensure their acceptability prior to the Completion Date.
- B. Prior to the Completion Date or testing by the OWNER, the CONTRACTOR's Cathodic Protection Specialist shall test all equipment and notify the CONTRACTOR that the installation is complete and ready to be turned over to the OWNER. The tests shall be conducted in the presence of the ENGINEER. The ENGINEER shall be notified a minimum of 3 days before testing begins. Measurements, locations, dates and test equipment shall be recorded and a copy shall be submitted by the CONTRACTOR to the ENGINEER.
- C. The CONTRACTOR's Cathodic Protection Specialist shall perform tests to ensure proper installation and operation of the cathodic completed cathodic protection system. Cathodic protection testing shall follow the guidelines set forth in the following:
  - 1. NACE Standard Recommended Practice, RP0169-83, Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
  - 2. NACE Publication 10A190, Measurement Techniques Related to Criteria for Cathodic Protection of Underground or Submerged Steel Piping Systems.
- D. Reports:

1. After completion of all tests and inspections, the Cathodic Protection Specialist will provide a detailed report of deficiencies to the CONTRACTOR. The CONTRACTOR shall make all repairs necessary to correct these deficiencies at the CONTRACTOR's sole expense.
  2. The CONTRACTOR's Cathodic Protection Specialist will retest items that have been repaired by the CONTRACTOR. All testing, deficiencies, and corrections shall be summarized in a report and submitted to the OWNER.
- E. After the CONTRACTOR's Cathodic Protection Specialist has tested and verified proper installation of all cathodic protection facilities, the Cathodic Protection Specialist and ENGINEER will energize, test, and adjust the system. Any construction defects identified during these tests shall be located and corrected by the CONTRACTOR.

**END OF SECTION 26 42 00**

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## SUMMARY SHEET

Section name: TEST STATIONS  
Section number: 26 42 01  
Prepared by: Les Nelson  
Reviewed by: Les Nelson  
Date issued: Jun 2010  
Description: SPU Design Standards and Guidelines (DSG)

Revision #	Date	Paragraph(s) revised
1	06/01/10	Insert

**WARNING:** The standards and guidelines do not relieve licensed engineers from their responsibilities as outlined by the code of ethics and rules of practice. All specifications require editing and review by the project's licensed engineer and must be tailored to the conditions and needs of the project. The guidelines provide policy, clarity, and advice on how design should be conducted by and for Seattle Public Utilities. However, it remains the responsibility of the licensed engineer to properly interpret and apply the guidelines as appropriate to meet the needs of the project. If these standards and guidelines contain any contradictions with other standard engineering practices, the licensed engineer is responsible for identifying and resolving them.

This Section covers the work necessary to furnish and install test stations to provide for monitoring of system performance. Both in-ground, at grade and above ground post mounted are described in this specification.

Note: This specification will be revised in the next version (v.3) of the Design Standards and Guidelines (DSG). This should be considered a starting point for a specification for a generic impressed current cathodic protection system.

Note: All specifications are edited for project-specific requirements.

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## **PART 1 GENERAL**

### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Divisions 01 Specifications Sections, apply to this Section, including:
  - 1. Section 01330, Submittals.
  - 2. Section 16640, Impressed Current Cathodic Protection System.

### **1.02 SUMMARY**

Note: This Section will be revised in the next version (v.3) of the Design Standards and Guidelines (DSG).

- A. Section includes:
  - 1.

### **1.03 DEFINITIONS**

- A. The following definitions are used throughout the Bid Documents:
  - 1. Ferrous Metal Pipe: Any pipe made of steel or iron, or pipe containing steel or iron as a principal structural material, except reinforced concrete pipe.
  - 2. Foreign Owned: Any buried pipe or cable not specifically owned or operated by the OWNER.
  - 3. Lead, Lead Wire, Joint Bonds Cable: Insulated copper conductor; the same as wire.
  - 4. Electrically Continuous Pipeline: A pipeline which has a linear electrical resistance equal to or less than the sum of the resistance of the pipe plus the maximum allowable bond resistance for each joint as specified in this section.
  - 5. Electrical Isolation: The condition of being electrically isolated from other metallic structures (including, but not limited to, piping, reinforcement, casings, etc.) and the environment as defined in NACE Standard RP0169-83.

### **1.04 SUBMITTALS**

- A. Provide catalog cuts and other information for all materials that show compliance of those materials with these Specifications. The Contractor shall also provide submittals for the test equipment.

### **1.05 SITE INFORMATION**

- A. Location: [Greenfield site at 1234 North Avenue Street, Seattle, WA 98101]

- B. Serving Utility: [Seattle City Light, 700 5th Avenue, #3200, Seattle, WA 98104, John CommercialRep, 206-684-3000, John.CommercialRep.scl@seattle.gov]
- C. Service Source: [Underground to utility-owned pad-mount transformer, 480/3/60, 400A nominal, 12,000A available fault current before motor contribution]

## 1.06 COORDINATION

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## 1.07 QUALITY ASSURANCE

- A. Provide a Cathodic Protection Specialist as specified in Section 26 42 00, Impressed Current Cathodic Protection System.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing only the standard of quality and general configuration desired. Products of other manufacturer's will be considered.

### 2.02 MATERIAL SUPPLIERS

- A. Suppliers listed below can usually supply the types of materials specified in this Section. Alternate suppliers will be considered, subject to approval of the Engineer.
  - 1. Test Stations and wiring:
    - a. Farwest Corrosion Control, Everett, WA.
    - b. Mesa Products, Inc., Tulsa, OK.
    - c. Norton Corrosion Limited, Woodinville, WA.

### 2.03 WIRES FOR TEST STATION CONNECTIONS

- A. General: Conform to applicable requirements of NEMA WC 3-80, WC 5-73, and WC 7-88.
- B. Test Stations: Single-conductor, No. 10 AWG stranded copper with 600-volt XHHW, RHW, RHH, TW, or THWN insulation and single conductor, No. 12 AWG and No. 6 AWG stranded copper with 600-volt HMWPE insulation. Insulation color shall be as shown.
- C. Insulation Colors: As shown on the Drawings.

## 2.04 CATHODIC PROTECTION TEST STATION

- A. Aboveground Test Station model "T-3" manufactured by Tinker and Razor or "Big Fink" manufactured by Cott.
  - 1. Mounted on HDPE riser pipe 3-1/2" OD X 5' L. Yellow
  - 2. Polycarbonate top. Blue.
  - 3. tainless steel bolting hardware
- B. B. In Ground, at grade per City of Seattle Std. Plan 360.

## 2.05 PERMANENT REFERENCE ELECTRODES

- A. Self-Contained Copper-Copper Sulfate Reference Electrodes:
  - 1. Material: Permanent type, self-contained copper-copper sulfate reference electrode.
    - a. Design Life: 30 years minimum.
    - b. Wire: No. 14 RHH-RHW wire with yellow insulation. The wire shall be attached to the electrode and insulated with the manufacturer's standard connection. Connection shall be stronger than the wire.
    - c. Special Backfill: Saturated gelatin backfill.
    - d. Electrode Manufacturers, or approved equal: Electrochemical Devices, Inc., Model UL-CUG-CW.
- B. Zinc Reference Electrodes:
  - 1. 5 lb zinc ingot in prepackaged backfill.
  - 2. Backfill shall consist of 75% gypsum, 20% bentonite and 5% sodium sulfate.

## 2.06 CONDUIT, LOCK NUTS, AND STRAPS

- A. Rigid Steel Conduit and Fittings: Hot-dipped galvanized meeting the requirements of ANSI 80.1, ANSI 80.4, UL and the NEC. Set-screw type fittings shall not be used.
- B. PVC Conduit and Fittings: Schedule 40, UL listed for direct burial. Conduit and fittings shall meet the requirements of NEMA TC and TC3, Federal Specification W-C-1094, UL, and NEC.
- C. Conduit shall be sized in accordance with the NEC and shall be of such size and so installed that conductors may be drawn in without injury or excessive strain.
- D. Lock nuts, Two-Hole Straps, and Miscellaneous Hardware: Hot-dipped galvanized steel.

- E. Conduit Bushings: Threaded plastic or plastic-throated galvanized steel fittings.

## 2.07 THERMITE WELD MATERIALS

- A. General: Thermite weld materials shall consist of wire sleeves, welders, and weld cartridges according to the weld manufacturer's recommendations for each wire size and pipe or fitting size and material. All welding materials and equipment shall be the product of a single manufacturer. Interchanging materials of different manufacturers will not be acceptable.
- B. Molds: Graphite. Ceramic "One-Shot" molds will not be acceptable.
- C. Adapter Sleeves: Provide for all wire sizes. Prefabricated factory sleeve joint bonds or bond wires with formed sleeves made in the field are acceptable.
- D. Field-formed joint bonds sleeves shall be attached with the appropriate size and type of hammer die provided by the thermite weld manufacturer.
- E. Cartridges: Cast iron thermite weld cartridges shall be used for all cast and ductile iron pipe and fittings. Maximum cartridge size shall be 25 grams for steel and 32 grams for cast and ductile iron materials, respectively.
- F. Acceptable Suppliers: Erico Products Inc. (Cadweld), Cleveland, OH; Continental Industries, Inc. (Thermo-weld), Tulsa, OK; or approved equal.

Pipe Material	Weld Type	Cartridge Size
<b>No. 4 AWG Wire and Smaller</b>		
Steel	HA, VS, HC	15 gm cartridge for #10 wires
Ductile Iron	HB, VH, HE	15 gm cartridge for #10 wires
Cast Iron	HB, VH, HE	15 gm cartridge for #10 wires

## 2.08 THERMITE WELD CAPS

- A. Prefabricated weld cap with coating and suitable primer, such as Handy Cap II with Royston Primer 747, as manufactured by Royston Laboratories, Inc., or approved equal.

## 2.09 PIPE AND FITTING COATING REPAIR MATERIAL

- A. As recommended by the pipe or fitting coating manufacturer. Repair coating for spot damage at thermite weld connections not covered by standard pipeline coating repair procedure or thermite weld cap shall be 100 percent solids epoxy that can cure in submerged or buried conditions.

## 2.10 WIRE CONNECTORS

- A. One-piece, tin-plated crimp-on lug connector as manufactured by Burndy Co., Thomas and Betts, or approved equal.

## **2.11 COMPRESSION CONNECTORS**

- A. Compression connectors for wire splicing shall be "C" taps made of conductive wrought copper, sized to fit the wires being spliced, Burndy Type "YC" or approved equal.

## **2.12 ELECTRICAL TAPE/HIGH VOLTAGE RUBBER SPLICING TAPE**

- A. Linerless rubber high voltage splicing tape and vinyl electrical tape suitable for moist and wet environments, such as Scotch 130 C and Scotch 88 as manufactured by 3M Products, or approved equal.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Whenever the requirements of the Specifications or Drawings exceed those of the codes or manufacturer's instructions, the requirements of the Specifications or Drawings shall prevail. Where a larger size or better grade of material or a higher standard of workmanship is required, the most stringent requirement shall apply.

### **3.02 TEST STATION INSTALLATION**

- A. The general locations of the test stations are shown on the Drawings. Tolerance of plus or minus 5 feet in the East West direction will be allowed to accommodate actual site conditions. (tree roots, etc.)
- B. Test wires shall be attached to the pipe as specified under WIRE CONNECTIONS, this Section.
- C. Test and reference electrode wires shall be buried a minimum of 36 inches below finished grade.
- D. Wire connections to test station terminals shall be with crimp-on spade lug terminals, except where solid wire is specified.
- E. Install concrete marker post at each test station location. Marker posts shall extend 3 feet below grade. The marker posts shall show test station and pipeline station. Locate marker post at the edge of the right of way or where designated by the Engineer.

### **3.03 REFERENCE ELECTRODE INSTALLATION**

- A. Prepare reference electrode with specified backfill in accordance with the manufacturer's written instructions. Place reference electrode within the pipeline trench excavation 6 inches from the pipe below the springline in a vertical or horizontal position. Where the Owner's pipeline crosses foreign pipelines, place the electrode between the foreign and Owner's pipeline. Reference electrodes shall be backfilled with native trench material. Terminate wires in the test stations.

### **3.04 WIRE CONNECTIONS**

- A. The electrical connection of copper wire to steel, ductile and cast iron surfaces shall be by the thermite weld method. Observe proper safety precautions, welding procedures, thermite weld material selection, and surface preparation as recommended by the welder manufacturer. Assure that the pipe or fitting wall thickness is of sufficient thickness that the thermite weld process will not damage the integrity of the pipe or fitting wall or protective lining.
- B. Before the connection is made, the surface shall be cleaned to bare metal by making a 2-inch by 2-inch window in the coating, and then filing or grinding the surface to produce a bright metal finish. The use of a resin, rubber, or shellac impregnated type grinding wheels will not be acceptable. The prepared metal surface shall be dry.
- C. Wire sleeves shall be installed on the ends of the wires before welding to the metal surface. Thermite welding shall be performed in strict accordance with the manufacturer's written instructions. After the weld connection has cooled, remove slag and physically test wire connection by striking a glancing blow with a 16oz. hammer; remove and replace any defective connections.
- D. Install a prefabricated thermite weld cap over each completed connection. All exposed metal surfaces not covered by the thermite weld cap shall be repaired in accordance with the coating manufacturer's recommendations. All damage to the pipe lining shall be repaired in accordance with the lining applicator's recommendations. Thermite weld cap shall be adhered to pre-primed and tack dry surface in accordance with the manufacturer's instructions.

### **3.05 WIRE INSULATION REPAIR**

- A. Wires shall be handled with care. Splices for damage to the wire insulation shall be required by spirally wrapping (50 percent overlap, minimum) with two coats of high voltage rubber splicing tap and two layers of vinyl electrical tape. Wire splices shall be made with suitable sized compression connectors as specified under PRODUCTS, this Section, or mechanically secured and soldered with rosin cored 50/50 solder. Compression connectors shall be made with the manufacturer's recommended compression tool. All splices shall be approved by the Engineer.

### **3.06 TEST EQUIPMENT**

- A. Before construction begins, the Contractor shall obtain the test equipment necessary for electrical continuity testing as specified under ELECTRICAL CONTINUITY TESTING and the following test equipment.
  - 1. A Model RF-IT radio frequency insulator tester, as manufactured by Tinker & Rator, San Gabriel, CA; or approved equal.
  - 2. A Model 87 Digital Multimeter with case and test leads, as manufactured by Fluke Corporation, Everett, WA; or approved equal.

3. Two Model "Stealth 3" (SRE-010-CPY portable) copper-copper sulfate reference electrodes as manufactured by Borin Manufacturing, Bel Air, CA; or approved equal.
- B. The test equipment shall be stored at the project site for the Contractor's use and shall be maintained in accurate, working condition at all times. The test equipment shall be available to the Engineer for testing purposes.

### **3.07 INSULATED JOINT TESTING**

- A. The Contractor's Cathodic Protection Specialist shall test each insulated joint after assembly. All damaged or defective insulation parts shall be replaced by the Contractor.

### **3.08 TESTING**

- A. After the Physical Completion Date, the Contractor's Cathodic Protection Specialist shall test the pipeline to ensure proper installation and operation of the test stations. Any construction defects identified during testing shall be located and corrected by the Contractor. These tests shall be made in the presence of the Engineer. Provide the Engineer with three days advance notice before beginning tests. All test data shall be recorded and submitted to the Engineer.
- B. Test stations shall be checked as follows:
  1. Pre-test all reference cells in water to ensure correct readings.
  2. Test all test station wire connections prior to AND after backfill AND prior to any required paving.
  3. Test after final termination and record values as "native" readings prior to energization of the cathodic protection systems.

**END OF SECTION 26 42 01**

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